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PROCEEDINGS: THE NATIONAL CONFERENCE ON AIR POLLUTION (3rd) HELD IN WASHINGTON, D. C., 12-14 DEC 66

National Center for Air Pollution Control
Washington, D. C.

1966

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PROCEEDINGS: THE THIRD NATIONAL
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II

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AIR POLLUTION...

. . . Does not exist because it was inevitable, nor because it cannot be controlled. Air pollution is the inevitable consequence of neglect. It can be controlled when that neglect is no longer tolerated.

It will be controlled when the people of America, through their elected representatives, demand the right to air that they and their children can breathe without fear.

Lyndon B. Johnson
Message to the Congress
January 30, 1967

THE THIRD NATIONAL

Air pollution is a serious threat to the health, safety, and economic well-being of the American people. The Third National Conference on Air Pollution was called to explore the nature of this threat and to devise a program of action to clean up the air.

The Conference provided a forum for all sides of this enormously complex problem. It was broadly representative of government, industry, the professions, and voluntary agencies and groups. The discussions were unusually provocative. It is a pleasure to transmit the proceedings of this significant and productive Conference.

John W. Gardner

Secretary of Health, Education,
and Welfare

CONFERENCE ON AIR POLLUTION

At this National Conference on Air Pollution, almost 4000 people from every avenue of life documented the damage done to health, life, property and welfare by air pollution.

Understandably, their first concern was health. While cleanliness, comfort, beauty, and dignity are among our goals, the safety of people is an absolutely minimum requirement in pollution control.

This conference has moved us appreciably nearer to our objectives by its clear mandate to control now.

William H. Stewart

Surgeon General
Public Health Service

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FOR CLEAN AIR
VICE PRESIDENT OF THE UNITED STATES

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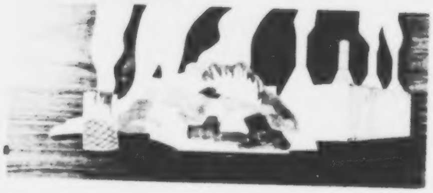

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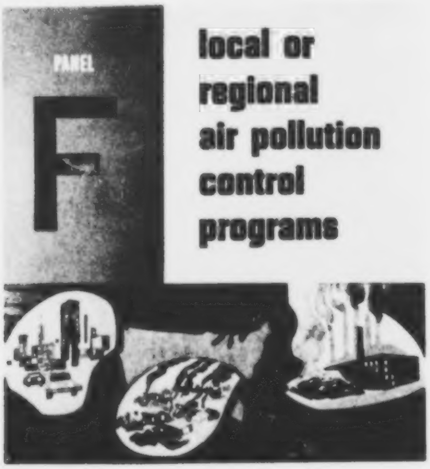

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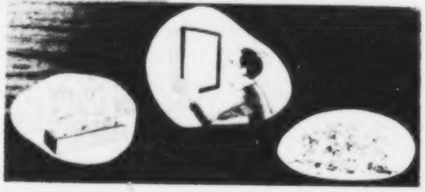

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CONTROL NOW

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December 12, 1966

PLENARY SESSION

Chairman William H. Stewart, M.D.
Surgeon General
U.S. Public Health Service

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". . . assistant chief, National Center for Air Pollution Control . . . diplomate, American Academy of Sanitary Engineers and American Board of Industrial Hygiene . . . former Cincinnati professor . . ."

WELCOME TO THE CONFERENCE

ARTHUR C. STERN
Executive Secretary,
National Conference on
Air Pollution
U.S. Public Health Service
Washington, D.C.

As Executive Secretary of this conference, I bid you all welcome.

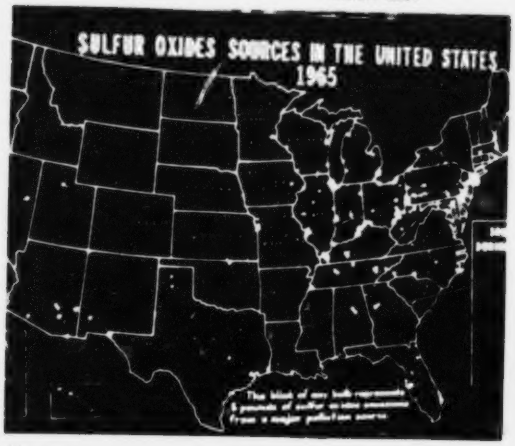
To set this conference in proper perspective, let us look at its 1958 and 1962 predecessors. The 1958 Conference discussed, "Where do we stand in air pollution research?" At the 1962 Conference, we faced the question: "Where do we stand in air pollution control technology?" And this conference will discuss, "Where do we stand in applying air pollution controls?"

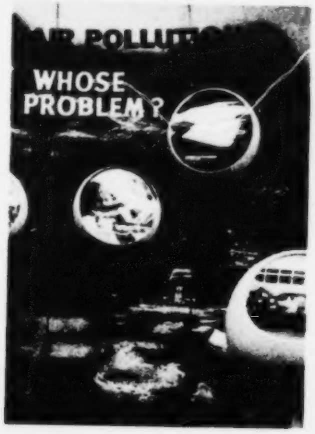
Our conference is organized with plenary sessions in this hall today and Wednesday. Tomorrow our group will be divided into eight panel sessions.

In Exhibit Hall I, directly below this hall, there are 50 exhibits; four more are in the Concourse of States and one is directly in front of the hotel. In Exhibit Hall III, there will be a continuous showing of the largest collection of air pollution films ever assembled.

We have produced for this conference 13 new publications which are available at the Conference Publications Exhibit. Publications are also being distributed at many other exhibits.

This conference focuses the eyes of the nation on the problem of air pollution. During these three days, 111 speakers and numerous discussants will consider the subject from many angles and give us new challenges and new directions. Out of their presentations and your discussions will come, we anticipate, the controls we need now for clean air.





THE PROBLEM OF AIR POLLUTION

I can't think of any place you could come to where the environment is better to discuss air pollution than right here in Washington, D.C. Congress is out of session, but there is still a little "hangover." And those of us in the Executive Branch, or those of us who are hybrids between the Executive and Legislative Branches—like a Vice President—we, too, contribute our fair share to "air pollution."

I am very pleased—in the light of what I have been reading in the press about the many dangers here—to see that Dr. Stewart is here this morning to take care of any casualties that may come along during this Conference.

I am delighted to know that my friend, Senator Edmund Muskie, is going to be the speaker at your banquet tomorrow night and that you are going to have John Charles Daly as toastmaster. If any of you have any doubt what Ed Muskie's line is, let me tell you that it is air pollution—along with his Chamber of Commerce descriptions of lobsters from Maine and all of the other many wonders of that part of America.

I am here this morning in the role of a sort of keynote speaker, even though I do not want to claim that honor. I am not here as an expert on air pollution except when it comes—according to some people—to smoke-filled rooms. And, in the light of the results of the recent elections, I am really not an expert on that, either.

THE VICE PRESIDENT'S ROLE

So, maybe, I should just take my stand once again as a "general practitioner." That is about what I consider myself in the organizational structure of our Government. With some 16 years in the United States Senate and two years as Vice President, one becomes, not a specialist, not an expert, but, hopefully, a man with a wide range of interests, and possibly one who, without being himself a technician, can at least arouse your curiosity, so you'll listen when the technicians go to work.

I am supposed to be the fellow that gets things started so that the experts can take over. Somebody once said that experts should be on tap and not on top. I think that is also a good axiom in politics and in all matters of public policy.

HUBERT H. HUMPHREY
Vice President
of the United States

THE CONDITION AMERICA CONFRONTS

Old Samuel Johnson had some sound advice which we can use with advantage this morning. You remember, that great philosopher and writer (who was at times almost a cynic, but in a delightful manner) said that "nothing concentrates a man's mind like the imminence of his hanging."

I suppose that no matter how you reword it, that is just about as precise as you can get it.

I might add that, this morning, we should concentrate our minds on the problems we face in terms of the atmosphere that surrounds us, the air we breathe, and the fact that more people have their eyes filled with tears today due to smog than at any other time in our national history. There is more coughing, more hacking, more crying, and more dying, due to air pollution than ever before. So, let's concentrate our attention before we have no attention left to concentrate.

DON'T WAIT FOR A CRISIS

It seems to be our American habit in both domestic and foreign affairs to wait until things get really bad before we arouse ourselves to action. I hear every day in Washington: "Well, before things get better, they will have to get worse." The real test around here is whether or not you have enough judgment to know when they are "worse enough" before you start to make them better or whether they will get so bad that there is no way at all to redeem the situation.

PARADOX OF OUR NATURAL ABUNDANCE

I cannot help feeling that we are just about six to ten, maybe even fifteen, years behind time in seriously getting down to work on this problem of air pollution. What an amazing situation this is: waters in our lakes and streams polluted, here in a nation that is blessed with more fresh water than any other nation on the face of the earth; and the air, the most vital feature of the environment in which we have to live, even more polluted, in a nation that prides itself on having more scientific advances and technological achievements than any other nation on the face of the earth.

THE WORLD'S NUMBER ONE POLLUTION PROBLEM

I have been delivering of late a series of lectures on what we call the scientific and technological gap. It is the ever-widening gap which separates the United States, with its advanced technology, with its tremendous developments in science and discovery, not only from the underdeveloped or the developing areas of the world—of Asia, Africa, and Latin America—but also from Western Europe. Yet, with all this achievement, with all of our institutions of higher learning, with all of our high-paid corporate executives, with all of our Government officials, there is no nation on the face of the earth that lives in so badly polluted an environment as ours.

We have the number one air pollution problem. It's nice to be first—except when it comes to being first in misery. I suggest that, in this contest, we ought to be willing to put up with second or third or last place!

I don't want to overdraw the seriousness of the current state of the problem. Possibly I am—like many of you—the victim of what I read and what I hear. But one prominent meteorologist, Morris Neiburger, of the University of California at Los Angeles, has predicted that if things continue as they are now, the world's atmosphere will grow more and more polluted until, a century from now, it will be too poisonous to allow human life to survive.

I can only say that we don't intend to let that happen. But that is the sort of shock treatment that tells us what could happen unless man puts his mind to this problem. Air pollution seems already to be taking a serious toll of human life.

BASIC REALITIES

I think we can point out this morning—and you will point out during this Conference—that air pollution, first of all, is unnecessary; science and technology can do something about it; number two, that it is physically, from a health point of view, very dangerous; number three, that industrially and from an economic point of view, it is very costly; and number four, that from the point of view of human relations and democratic government, it is intolerable.

People are entitled to live in a wholesome environment; hopefully, to have a job; hopefully, to have a decent home in which to live; hopefully, to have a decent community, with good streets and parks and playgrounds. But above all, they are entitled to have what God Almighty gave them and we have no right to rob them of—fresh air to breathe.

It is bad enough for man to destroy the earth, but to destroy the atmosphere, I think, is reaching beyond his jurisdiction. And it is about time that we called a halt to it.

THE TOLL OF AIR POLLUTION

I said that there is a serious toll of human life involved. And there is. The nation that suffers the most is ours—from emphysema, for example, a disease associated directly with air pollution. Emphysema is the fastest-growing cause of death in this country today. Among American men the death rate from emphysema is almost ten times what it was in 1950. Each month 1,000 more workers are forced prematurely onto the Social Security rolls because of the crippling effects of this disease. Significantly, deaths from emphysema are twice as high in our cities as in our rural areas.

Now, if there happens to be a relationship between the filthy air of the urban areas and the relatively clean air of the rural countryside, the coincidence only underscores what anybody with an eighth-grade education already knows. What a pity it is to think that we can build glistening towers, magnificent buildings, incredible designs for machines and devices, and yet we don't know how to control the smoke that comes out of a smokestack.

Like emphysema, other major respiratory diseases—bronchitis, asthma, lung cancer, not to mention the common cold—are clearly linked with air pollution, even though the link is incompletely documented as yet. However, there seems to be a growing body of evidence that all of these disturbances of the lungs and throat are related indirectly to the atmosphere that surrounds us, the air we breathe.

SUGGESTION BY LEADING PROFESSIONAL GROUPS

It is on this basis that in the four years since the last National Conference on Air Pollution was held, the American Medical Association, the American Thoracic Society, and a number of other organizations interested in public health have called for national action to control air pollution.

If we get as excited about air pollution as we are about cigarettes, and do twice as much about it, I think we will make some progress at this Conference. I happen to agree with these great associations—the American Medical Association and the American Thoracic Society—that unless we tackle air pollution in real "deadly" earnest, we shall be taking an intolerable risk with the health and the lives of innocent people.

CONSTITUTIONAL MANDATE

Let every one of us keep in mind the mandate of the Constitution. Every officer on this platform has taken an oath to uphold the Constitution, to defend it against all foes, domestic and foreign. As most of you are well aware, there are just two mandates in the Constitution; the rest of it is optional. Just two things are required of the Federal Government: to provide for the common defense and to promote the general welfare. Everything else in the Constitution is optional.

We *are* providing for the common defense, but to promote the general welfare is what this Conference is called for. And we must settle down to the task in these days ahead to try to find some answers.

ACTION

We can say that we have begun to move. As I said earlier, beginning and moving in America are generally tied to some moment of crisis. I don't know what we would have done if the Russians hadn't come up with *Sputnik*. I think our educational system would still have been in the doldrums. They scared the living daylights out of us, and today we have a better educational structure—not because of men of good will alone, not only because of men like Secretary Gardner, who believes in the doctrine and the application of standards of excellence, but also because the American people became frightened.

Regrettably enough, we do something finally about our cities when there are riots. We do something about most problems because we are afraid. It has been said, jokingly, but all too often with enough supporting evidence to prove the point, that if a nation can come up with a few Communists, it can get aid from us. Fear of the Communist threat precipitates action, even though you and I know that there ought to be a world in which people are well fed, clothed, and educated, even if there had never been a Communist.

I don't happen to think that we ought to be motivated all through our lives by the fear of evil consequences. It would seem much better that we do what is right because it is the right thing to do, and because it is the most constructive thing to do.

PROGRESS UNDER CLEAN AIR ACT

The Clean Air Act (of 1963) was an important step forward. But how long it took to get it! With all the struggle that went on for air pollution control and water pollution control you would think that some people thought they "owned" the air and that control was an "invasion" of private property or private rights, and that some other people "owned" the waters of the rivers and the lakes.

Many communities and States have, fortunately, already taken advantage of the limited financial incentives, the technical assistance, and the research backup which the Federal Government can now provide.

I believe that this Conference underscores one fact above all others—that the Federal Government is now involved in air pollution control, and it must be involved. But air pollution control needs more than involvement on the part of the Federal Government—it also needs the working cooperation of every element, every segment, of the American society.

We will have to go a long way before the problem that confronts us is in hand. We are late in getting started; the resources that we have to apply to it are limited, and the problem is immense.

All of us contribute to air pollution. Therefore, all of us must do our part in its control. In your panels in this Conference, you will undoubtedly outline for us how each of us can do his part.

STATE AND LOCAL RESPONSIBILITY

Not very long ago, air pollution was regarded as strictly a local problem. I remember when I was Mayor of Minneapolis in 1945, I had a big struggle trying to get an air pollution control officer appointed in the city government. We finally got someone who was given the title. He had ability, but he had no authority.

We Americans always feel a little better, when we see a problem after the reformers come along and call it to our attention, if we can just pass a law. At times, we are not so worried about the enforcement of the law or even about its observance, if we just pass the law.

We passed laws, we passed ordinances at the local levels, and in some States we passed some good State laws. But neither the States nor the Federal Government have played a significant role up until now in dealing with this problem. Most of the approach to the problem of air pollution has thus far been on a local, city-by-city basis—and most of the time, ineffective.

ROLE OF CREATIVE FEDERALISM

Some people believe that the problem can be solved locally, and they believe it very strongly. Others suggest that we have come full circle, and that the Federal Government must assume the full responsibility. Well, I am not like that old fellow who said, when he was asked to take a stand on an issue in the local election: "I have friends on both sides, and I stand squarely with my friends."

I think there is a rather realistic and meaningful approach to our problem. It is my view that you can't do this locally, and it is my view that the Federal Government—on every single problem that confronts this nation today—while it must assume a sense of direction, or coordination, and do its part, can't do it all. And even if it could, it shouldn't.

I happen to believe in what we call creative Federalism. I happen to believe in our system of government. I happen to believe that social responsibility is not only the duty of government—it is also the duty of citizens.

I happen to believe that one of the ways in which you can strengthen local and State government is to bring about a partnership of the three levels of government—Federal, State, and local.

So what I say is that neither approach, local control alone or Federal control alone, is adequate by itself. What we need is a working partnership among all levels of government, Federal, State, and local—a partnership that must also include private industry.

VOLUNTARY MOBILIZATION

Let me repeat that every problem that confronts American society today requires the mobilization of our resources, all of them—Federal, State, local, and private. You can't get your cities rebuilt by the Federal Government, or by the local government alone, or by the State government alone, or by private industry alone. You *can* do it working together. And if we can't perfect a formula to do that, then our democracy is a failure.

But I think that we in our democracy know how to put together a working plan. I have a few suggestions that may help you to put together a working plan here. In your discussions I urge you not to feel bound by those outworn notions about *who* should do *what* to control air pollution. If you have expressed such a point of view before, stop reading your own propaganda.

SOUND DIVISION OF RESPONSIBILITY

I think we ought to cast aside that which we have found did not work in the past, and do some fresh thinking. I hope you will think from this time forward about who can do what most effectively.

How do we divide up this responsibility? How do we share the burden? How do we do it, knowing that each partner is to carry his full share of the load?

Air pollution will not yield to anything less than a determined and coordinated effort by all sectors of our society. We have to declare total war on air pollution. And that means that we have to ask every part of our society to engage in the struggle.

NEED FOR REGIONAL TEAMWORK

Everyone seems to agree that the most efficient and effective way to control air pollution would be on a regional basis. In the words of the Scripture: "The wind bloweth where it listeth." The wind or the air has no regard for the lines that we mortals draw upon our maps, separating one State from another, or one city from the surrounding suburbs.

In the month of October, I flew over a great metropolitan area in the Upper Midwest, the Great Lakes area. I saw smokestacks belching forth sulfurous gases that filled the air with poison. I asked the local officials: "Don't you have an ordinance about this?"

"Oh, yes."

"What are you doing about it?"

I didn't get an answer. But I want to tell you, if the local law enforcement officials were as active in enforcing their air pollution ordinances as they are in enforcing traffic ordinances we would get something done. I don't know why it is any more illegal to overpark our cars and clog the streets than it is to violate an air pollution ordinance and clog the air.

I recognize the problems that are involved in local jurisdictions in this matter. But just as we need a nonproliferation treaty relating to nuclear weapons among nations, we also need nondiffusion treaties between States that share the same airshed. We need regional compacts, conforming to Federal standards, backed up by Federal law, and strengthened by cooperation with Federal agencies.

I must say, in all candor, if there is now a single interstate regional air pollution control program anywhere in this nation that works, I have not heard of it. But that doesn't mean that such a program can't work, because it can.

Air pollution is a challenge to the vision and to the responsibility of private industry as well as to government. In fact, it is the private sector which makes a major contribution to the pollution of the air. Industry is the source of a great deal of air and water pollution. It has, or it should have, a very real interest in upgrading the quality of the communities in which it functions.

I think industry wants to extend your life. I happen to be one who believes that American business is socially conscious, that it recognizes its obligations as a working partner in community life. Industry sometimes doesn't quite know what to do, because the pattern hasn't been designed yet. That is where the public official comes in, working with his private brother to find such a pattern, to find a workable formula.

THE COSTS OF INACTION

Not only does industry have a real interest in upgrading the quality of the communities in which it functions, but also, if present trends continue, the costs of polluted air to industry itself are likely to mount.

I must admit to disappointment that control of air pollution has thus far too often been seen by some industrial firms as "a nuisance" to be endured or to be postponed.

This attitude is even shared by some units of local government, although any number of reasonable accountings have already revealed that the long-run costs of pollution are far greater than the cost of its control.

CURBING OFFENDERS

So I appeal this morning as a fellow citizen, for local and State responsibility. I ask the law enforcement officers—who are perfectly willing to go around and arrest a drunk, or someone who is molesting someone else, or someone who threatens someone else, or someone who overparks his car—I ask them to be equally vigilant on other transgressions against the public welfare.

One of my weaknesses is that I digress in these speeches on some one public issue. But I think of the slum areas of our cities: there are ordinances in every city that say, "You are not permitted to put the garbage all over the lawn." There are ordinances that require you to have safe wiring and good plumbing. I want to say that, if the law enforcement officers of State and local governments were as interested in slum tenements—as to their safety and their fitness for human occupancy—as they are in a night club—where they put signs saying that "only 400 people can occupy this room," where they run in a public health officer about three times a week to see that the dishes are being cleaned right, where they check the sewer lines and the rest rooms and the wiring. If they would do a little of that kind of checking in the slums, we wouldn't have so many slums.

I know. I tried it. It works.

MORE UNIFORM STANDARDS AMONG CITIES

There is another problem relating to local government and its part in air pollution control: standards of control vary greatly from city to city and from State to Sate. I think we can ask this question, and I know industry does: "Is it realistic to expect industries in one city to give zealous support to enactment of stringent local regulations if they have no assurance that their competitors elsewhere will have to make commensurate expenditures?"

How can that assurance be given? That is a question that you need to face here. If the city of Denver is to insist that every industrial plant abide by the law and has strict enforcement, what about the city of Minneapolis, my city, or the city of Detroit, or Chicago, or St. Louis?

Most of American industry today is highly competitive, and it has competitive plants in many cities.

ACHIEVING A CONSENSUS

These are some of the very real problems which industries and the communities in which they function must face in any coordinated and effective effort to clear the air. Your Government is currently and actively concerned with these problems in the hope that it can help to find a solution. The purpose of consultation in a conference like this is not for Federal agents to tell you what to do, but for you to advise and counsel the Federal representatives as to what you think will be best to do. These individual citizens, the representatives of local and State governments and of private industry, working together with the Federal representatives, may come to an agreement, a consensus, a concerted feeling of what *can* be done.

UNSOLVED TECHNICAL PROBLEMS

I realize that there are still problems remaining to be solved in air pollution technology. I am not unaware of that. I spent ten years as chairman of a subcommittee on scientific research of the United States Senate, and I am a pharmacist; I have studied in chemistry; I think I know a little bit about some of the technical problems that face industry.

Some of the most ubiquitous and damaging gaseous products, the sulfur oxides, remain uncontrolled because we have not as yet developed a technology to deal with them efficiently.

The same is true of fumes from diesel trucks and buses.

Having said that, I cannot believe that this nation, which is preparing within the next two years to put a man on the moon, and finally to colonize it—to put men there so they can live there and return from there—I cannot believe that a nation that is capable of putting a man on the moon, and is contemplating interplanetary travel, is not capable of devising ways to control sulfurous gases and diesel fumes here on earth.

If we can't control the bus and what it spews out on our streets and in our air here on earth, what makes you think you can do anything on the moon once you get there?

I think we may do better on the moon, because we are not going to have any vested interests there. According to what we hear, at least, there will be no one carrying placards or petitioning us, or standing in the way.

SPACE AND MARINE COUNCILS

I happen to be Chairman of the National Aeronautics and Space Council. It is very interesting work. The Congress has seen to it that the Vice President has new duties from time to time. Two of the more recent enactments within the past six years have been to appoint the Vice President as Chairman of the National Aeronautics and Space Council, commonly known as the Space Council, dealing with the infinity of outer space; and only this last summer, to appoint the Vice President to be Chairman of the Council on Marine Resources and Engineering Technology, known as oceanography. (Any assignment I get is either out of this world, or down on the bottom of the ocean.)

But I can stand before you and tell you that my domain is less polluted than yours. From what I hear of the seas, they are in some danger, but not as yet as bad as certain areas on earth; and space, they tell me, is beautiful, magnificent. In fact, if you get up high enough, 100 miles or so, you can take a better picture of the earth than you can if you are up "only" 40,000 feet.

PROGRESS BY WORKING PARTNERSHIP

This nation has achieved—and this is where we get down to the practicalities—many of its greatest advances through working partnerships. I spoke earlier about creative Federalism as part of a working partnership. I looked at the audience and saw some people who seemed to say, "I've heard that stuff before." So have I. But then the question comes—does it work? Are there any examples? I am here to tell you that there are.

There is a working example of what I am talking about, a working partnership among the National Aeronautics and Space Agency (NASA), the Department of Defense, and the Atomic Energy Commission, working together with a host of contractors in private industry which employ today over 400,000 skilled professional workers, with more than fifty great universities spread across our land, and with great banking institutions. So here we have the university-scientific community, private industry, Government, all working together in the space program.

Government couldn't do it alone, or if it did, it would not be within our traditional system. Industry obviously couldn't do it alone. The universities couldn't do it alone.

So we put them all together—our great universities, their schools of technology, science, engineering, and the life sciences (and we have had interdisciplinary work too). We asked them to find answers to problems that only ten years ago seemed impossible to solve—and we have found out how to solve them.

RESULTS OF COOPERATION

I am confident, with that same kind of teamwork, that we can do equally well with innermost space, this thin but infinitely precious envelope of atmosphere in which we breathe and live and work.

When we launch astronauts into space, we equip them with special suits, put them into costly capsules, take every precaution known to modern man, to insure that they will survive in a strange and hostile environment.

A space capsule, whatever its dangers and handicaps, is one place where there is no air pollution. It seems to me that here on earth we have a right to breathe free and easy in the open air, and to enjoy life, liberty, and the pursuit of happiness without resorting to smog masks.

I would put it another way, that any nation that is willing to make the investment that we are making to put a man on the moon ought to be able to find ways and means, and be willing to make an adequate investment, to help keep a man on his feet right here on earth, and to permit him to live a good life here. That is really what we are talking about.

AMERICA CAN ATTAIN WHAT IT WILLS

As your Vice President, I am here to tell you that our Nation can do anything that it wills to do. We have proved it. We are going to build a supersonic transport—we are going to solve every problem involved in it—the engineers say we can. We are going to be able to desalinate the water of the seas. We are already working up to a point where we can control genetics. We are going to be able to transplant an organ from the body of one person to the body of another on a regular basis. We are studying the secrets of life itself, hidden in the cellular structure, and even coming close to the point of artificial creation of life.

We are doing fantastic things when we will to do them. We are going to be able to put into orbit a manned orbiting laboratory. We will construct that laboratory in orbit. We will put it together. We will nail it together, so to speak. We will have men going in and out of that laboratory just as they go in and out of an underground plant or factory, or a factory on earth. And it will all be within the next ten years. We know that.

We are able to do practically anything that we want to do, if we really want to do it and if we are willing to dedicate the necessary resources to it.

We are talking now about building huge buildings under the sea. I have been involved deeply in this. We can now mine the seas. We can build a bulding bigger than this hotel on the bottom of the ocean, live in it; mine the manganese, the copper, the gold. Down there, we can do all these things.

We will be communicating all over the world through communication satellites. We will be able to have a University of the World in ten years, so that students at our great universities will be able to hear in instantaneous translation the greatest philosophers and teachers in the world in ten different countries on the same day, and have the message brought to them in their native tongues. We can do all this.

So don't tell me you don't know how to control some fumes coming out of a bus. Don't tell me that we are incapable of doing something about sulfur oxides. Don't tell me this—I don't believe it. I tell you that we ought to make up our minds to do this. We *have* to do it.

Or must we list the casualties every day, as we do in Viet Nam?

As a matter of fact, there are more people dying from emphysema than there are on the field of battle. I have a feeling that there is some "guerrilla warfare" that we are letting loose in this country, a hidden enemy known as air pollution.

We have the right, I think, to be free of the haunting fear that disaster may any day strike in any one of a large number of our cities. To free ourselves from this fear is our task, and this is our challenge.

TAKING ACTION NOW

The American people want to know what we must do to control now for clean air: not 20 years from now, but *now*.

Somebody once asked an old scientist, "What is the difference between the long run and the short run?" He said, "In the long run, you are all dead." I am a short-run man.

I enjoy life, liberty, and the pursuit of happiness. So I say, let's gear up for action I know there are going to be people here who will say, "Well, we have got to wait for more information." I have been engaged in academic pursuits myself. You can sit around waiting for more information all your life—there is always more information to wait for.

Yesterday, I boarded the replica of the Santa Maria. Christopher Columbus could have been waiting right now, right on up to the Queen Mary, if he had waited for all the information to come in.

One thing about Christopher Columbus, he didn't have much of a ship, but what he had, he got into. He set sail and got across the ocean. Of course, he didn't get to where he was planning to go, but at least he made the trip.

So what the Vice President is saying to you this morning, in characteristic style, is this: "Let's get with it." This is where the action is. Here is where we need the job to be done. We need to take action on a whole series of fronts. I know there will be those who will tell you, "we need to plan the whole thing out. We can't move until we have a massive plan for everything."

As I have said earlier, our problems are massive; it is going to take a massive effort; it is going to take coordination such as we have never known before; it is going to take pooling of the resources of America, and maybe, of the world.

Let's not keep waiting for the day when somebody comes in with a master plan. Every master plan has been altered, and your master plan will be altered too, before the ink dries on the first page.

What this country needs right now from you is a plan of action to meet the problem that is here this year and the immediate years ahead.

THE TASK OF THIS CONFERENCE

I charge this great Conference—it is a fine one, and grateful we are that you are here—I charge this great Conference with the responsibility of helping, not just our Government, but our country, our fellow Americans, to have an environment that is healthful and decent.

You can make your contribution by seeing to it that one of God's great gifts to mankind, the air we breathe, is as pure as God Almighty intended it to be for His children.

KEYNOTE ADDRESS: CONTROL NOW—FOR CLEAN AIR

JOHN W. GARDNER
Secretary of Health, Education, and Welfare

Let me join Vice President Humphrey in welcoming you to this Third National Conference on Air Pollution. You represent virtually every segment of American life and probably just as wide a variety of views. And you certainly represent almost the entire population of fully informed, technically competent people on air pollution. The fate of air pollution control in this country rests in the hands of the people in this room.

I hope you'll express your views fully and frankly during the next three days. This is your opportunity to be heard on one of the most complex and difficult questions facing the American people today.

I believe, and I think everyone in this room believes, that we *can* have clean air. We are at a point where we can tip the balance, where we can make the environment man's ally and not his enemy. But it will not be easy. Certainly we cannot afford further delay.

As the Vice President pointed out, pollution of the air has been going on for a long time. President Johnson has said: "Of all the reckless devastations of our natural heritage, none is more shameful than the continued poisoning of our rivers and the air."

The tragedy is that we've tolerated this for so long. Until quite recently, we put up with—and even attempted to justify—the hazardous and costly evil of air pollution because it was considered the price of progress. We now know that the opposite is true: we know that unless we put a brake on air pollution, air pollution will put a brake on progress.

This is no longer open to question. Our concern is not merely with a suffocating haze that offends our senses and soils our laundry, our paint, and our buildings, damages crops, and corrodes metal. We are dealing with a killer. People become sick and they die from breathing dirty air.

Only three weeks ago, the health officials of this Nation's largest city had to warn people with heart and lung diseases, respiratory ailments, or even bad colds to stay indoors during the spell of heavy smog. Mercifully the pall lifted before more drastic measures were called for and before hundreds of lives were lost. But the episode was frightening.

The ugly shroud of pollution that afflicts our east coast metropolitan centers thins out here and there, but it extends at least as far north as Boston and as far south as Norfolk.

Nor is the rest of the country free of the threat. In Pittsburgh, the Golden Triangle is tarnished again by an air pollution problem that is both less obvious and more complex than the old smoke problem under whose pall Pittsburgh almost disappeared three decades ago. The new stainless steel arch towering 630 feet into the air above St. Louis was virtually obscured last October (ironically, during Cleaner Air Week) by air pollution arising from both Missouri and Illinois, despite sunny skies and clear weather.

There is not enough air in the big sky over Texas to thin out the pollutants that pour upward from many of the thriving metropolitan centers of that State. The problem is felt in the mountain air of Denver and the desert air of Phoenix. Cities large and small have to wade through an almost daily bath of particulate filth and noxious gases.

In fact, there is no major metropolitan area in the Nation today without an air pollution problem. And the problem is getting worse. By 1980, this Nation's urban population will increase by a third, the number of motor vehicles by 40 percent, and our demands for energy by 50 percent.

WHAT CAN WE DO?

Our choices are narrow. We can remain indoors and live like moles for an unspecified number of days each year. We can issue gas masks to a large segment of the population. We can live in domed cities. Or we can take action to stop fouling the air we breathe.

Air pollution must be controlled at the source. As you know better than anyone else, we cannot treat air as we can treat water to make it tolerable. Moreover, we have to control for the worst conditions. The air that might be endurable for part of the year becomes at other times a threat to human survival. And we must control the air so that it's safe for everyone—for infants, for the sick, for the elderly, as well as for the ordinary citizen.

There is no doubt that public concern is mounting. At the national level this concern is reflected in a series of laws passed since the Second National Conference on air pollution four years ago.

First to emerge was the Clean Air Act of 1963. It authorized the Federal Government for the first time to make grants for State and local control programs, and to take enforcement action against interstate air pollution. It also expanded our research and technical assistance activities.

The 1965 Amendments to the Clean Air Act provided for Federal regulation of air pollution from new motor vehicles. And the 1966 Amendments, enacted just two months ago, authorized Federal grants to help States and local agencies *maintain* effective air pollution control programs.

These measures have created new opportunities for vigorous control efforts by industry and by all levels of government. Thus far, we have awarded approximately $10 million in grants to States and local agencies.

We have begun Federal abatement actions in nine areas. As you know, I have called for a series of abatement conferences on the air pollution problem in the New York and New Jersey area. The Vice President quoted the Good Book in saying that the wind bloweth where it listeth. We now have ample evidence that the wind bloweth across the Hudson in both directions and the first conference on this subject will be held on January 3, 1967.

We have set national standards for the control of emissions from new gasoline-powered motor vehicles. These standards will become effective for 1968 model cars which will appear next fall.

Since the Clean Air Act, the total funds available for State and local air pollution programs have increased by about 65 percent. Some $20 million is now being invested annually—about $5 million at the State level, $15 million at local levels. Although these amounts are far from adequate, they compare favorably with the combined State and local spending of about $12.7 million at the end of 1963.

There are now 33 State programs in being or under development, compared to 17 in 1961. And the number of local programs has increased from 85 to 130.

There have been stirrings on other fronts. Industry has begun to think seriously about the problem, and some firms have stepped up their anti-pollution efforts. Air pollution has had more scientific attention in the last few years, the last four years certainly, than in all the previous years in history.

While this response is encouraging, it is little more than a beginning. Most State programs lack adequate authority and resources. Only a half-dozen have more than a minimal abatement program. Few are able to serve communities which are too small to operate their own programs.

Our most recent estimate indicates that only 58 percent of the urban population of the United States is now served by local air pollution programs. And where programs do exist, their resources are meager. On a per capita basis, annual spending for local air pollution control amounts to about 15 cents. Yet at least 40 cents per capita is considered necessary for an adequate local effort.

Regional programs are virtually nonexistent. Only 5 of the 24 largest metropolitan areas are now served by regional activity of any sort. Sixty-nine million people—about one-half of the Nation's urban population—live in these 24 areas.

The truth is that we are actually losing ground in the fight against pollution. The smog continues to grow more dense even as we continue to talk about it.

Neither government nor industry has yet moved forward with the vigor and determination that this problem requires—the vigor and determination which were so well described by the Vice President.

State and local governments have been slow in seizing the opportunities for action. In particular, they have failed to establish the regional approaches demanded by a problem that ignores traditional state boundaries.

Most industries have yet to take vigorous leadership in combating air pollution. If pollution is to be prevented at its source, then industry cannot escape its responsibilities. The initiative for research and for the development of antipollution devices must be taken by industry—for its own economic well-being as well as to meet its public responsibilities.

But this is only a beginning. Cleaning up the air will call for a far greater investment of time, money, and creativity than we have yet been willing to devote to it.

Some people keep hoping for a simple, quick, or painless solution. It will never happen. The technical, economic and social factors involved are immensely complex.

Air pollution, like other environmental problems of metropolitanism, is compounded by improper land use, choked transportation, poor disposal of waste, and general lack of foresight in industrial and city planning. Controlling the sources of pollution might involve a community decision to invest in mass transit facilities rather than in new highways. It might call for the dispersal of factories and plants that spill contaminants into the air. It might depend on the use of new types of fuel and new sources of power.

We have to look at all these possibilities and many more. When the cars equipped to meet our new standards go on sale next year, we hope that we will have made a beginning toward using our streets and highways without adding to the burden of pollution in the air. But there will be about 120 million motor vehicles in use by 1980. This increase threatens to wipe out any progress we make in reducing motor vehicle pollution with the controls presently available.

We need to develop alternative possibilities with respect to the sources of automotive power—alternatives with less potential for fouling the air—and we need to press forward with research toward that goal as rapidly as we can. We need to look into the electric car, the turbine car, and any other means of propulsion that is pollution-free.

In view of the threat to health and safety, how practical is it for private cars to operate freely in our congested urban areas? Is it feasible, is it conceivable, to limit the use of non-emergency vehicles in the heart of our great cities during certain portions of the day? These are the kinds of questions we must ask ourselves sooner or later.

We must also move ahead rapidly on two fronts: first, to apply existing control technology as fully as possible; and second, to find solutions to the technical problems that are still beyond our knowledge.

There are several important sources of pollution about which we know very little. Sulfurous pollution and diesel exhaust are two outstanding examples.

We are now exposed, nationally, to some 23 million tons of sulfur dioxide per year. At our present rate of growth, this burden will reach the astonishing figure of 43 million tons by 1980. Yet we do not have economically or technically feasible means of removing this highly irritating and damaging pollutant from fuels or stack gases.

And similarly, as the Vice President pointed out, we are still helpless to do anything about the unreasoanble stench that pours from the tailpipes of diesel trucks and buses.

Some research is under way in these fields, but it is far from adequate, given the dimensions of the problem. Again, the challenge is squarely before industry. If science and industry can probe outer space, I am certain they can find ways of using our sources of energy without loading the air with damaging and toxic compounds.

As important as it is to expand our knowledge, however, it is even more important to apply the knowledge now at hand—to put it to use fully and vigorously across the Nation. We can expect our techniques and practices to improve over the years. But the best way to insure improvements is to put all our control technology to work wherever it can do any good. Once we do so, we will undoubtedly become creative about finding better and cheaper ways to curb pollution.

The battle against air pollution calls for strong Federal-State-local partnerships. One of the things I hope you will discuss is the question of appropriate responsibility, appropriate divisions of responsibility, between Federal, State, and local levels, particularly in the development of regional programs. I hope you will discuss how adjoining States and communities can iron out the intricate political and social problems that now prevent them from making common cause against this common problem.

Another matter which you will surely want to discuss at length is the question of standards. Lack of uniform air quality and emission standards serves as a deterrent both to States and communities and to industry. Until standards are devised, many communities will be reluctant to make the investments necessary to control air pollution. And unless the communities within a regional airshed require identical controls from the sources of pollution, their efforts are likely to be piecemeal and only partly effective.

I have been spending a good deal of time on the problems of the cities, and I think there is no example better than air pollution of the extent to which the multiplicity of jurisdictions in our metropolitan areas today hampers effective pursuit of the purposes of the people. This is certainly true in the problem before us. Sometimes it seems so complex that one wonders whether a solution is possible.

THE TASK OF THE CONFERENCE

I think of the cartoon that appeared several years ago in, I think, *The New Yorker*. A lady was buying a toy for her child at Christmas, and the salesman was saying: "Madam, this toy prepares the child for the modern world. No matter how he puts it together, it won't work."

It seems certain that we must find a solution for the metropolitan area problem, or we won't find a solution to the air pollution problem.

What kind of standards should be developed and how should they be applied in a uniform and consistent manner?

What's the proper place for and what are the limitations of, Federal incentives to industry to develop air pollution programs?

How can we make use of the techniques of systems analysis and of the aerospace industries in halting the pollution of the atmosphere?

These are only some of the questions that I hope you will ask yourselves in the time immediately ahead. I hope you will tell us of the measures that can be taken to clean up the air in every community throughout the country.

Let me make one final point. The purpose of all our efforts is to enhance the quality of life for the people today and for the generations to come. We want a humane environment—we want a benevolent environment—we want an environment in which the individual human being can live fully, in good health, free from the constraints that limit his potential. If our society continues at its present rate to become less livable as it becomes more affluent, we shall surely end in sumptuous misery.

The air is only part of our total environment and pollution is only one of the ravages that our civilization has wreaked upon it. We also have garbage dumps, dying lakes and poisoned rivers, noise, crowded communities, long hours of commuting, absence of green space, ugliness all around us. And surely this is not what we had hoped for from our great technology, nor the legacy we want to leave to later generations!

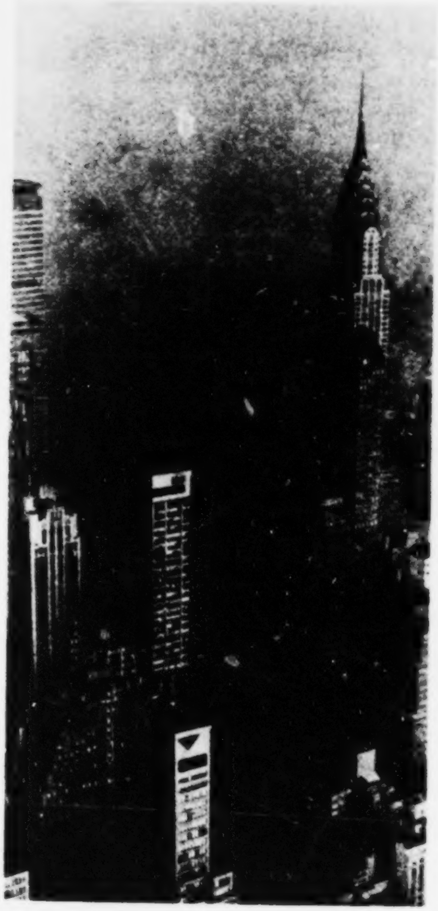
To help us meet this huge problem, I recently appointed a Task Force on Environmental Health and Related Problems and have charged its members to think at least 50 years ahead on these matters, to ask the difficult questions, and to come back to me next year with a report and a plan of battle.

I hope that you will join with them in worrying about these hazards to life and comfort and reasonable living, and in doing whatever is necessary to protect ourselves.

I sometimes feel that relatively few State and local officials or industrial leaders appreciate fully the pace at which the problem of air pollution is advancing. And those of you in this room who are aware of it can do much to spread the word.

I am sure that many government and industrial leaders have not adequately assessed the mood of the American people with respect to dirty air. If this is true, if it continues to be true, then we'll see a familiar sequence of events: the problem will get worse, and we shall lose ground steadily until some frightening incident (or a series of such incidents) occurs. Then an angry public will call for measures far more rigorous and militant than any we now contemplate.

We can wait and court disaster, or we can take action now to clean the air. I hope this conference will start us on our way. You are the people who are most aware of the problem, the most informed about it, you can contribute importantly to a good future for this nation.



NATIONAL CONFEREN
on AIR POLLUTION

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December 12, 1966

PLENARY SESSION

Chairman Philip R. Lee, M.D.
Assistant Secretary of
Health, Education, and
Welfare

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". . . physician and educator, advisor to the Public Health Service and the Agency for International Development . . . chairman of the AAAS Air Conservation Commission . . . former municipal health director . . . college president . . ."

THE STATE OF OUR ATMOSPHERE

JAMES P. DIXON, M.D.
President of Antioch College
Yellow Springs, Ohio

My task, as perhaps befits one who is identified with education, is both pedantic and speculative, pedantic in the sense that part of it is to get us to agree upon some definitions of what it is that we are talking about, and speculative because I can never restrain myself from behaving in that fashion.

We come to this conference with a sense of crisis about an absurd situation. The sense of crisis is revealed by the increasing efforts to define, to discuss, to speculate and prophesy about air pollution. Such discussion goes on at an increasing tempo among scientists, among politicians, and in the public press, radio and television. It is heightened by the statements of the President, the Vice President and the cabinet officers. It is heightened in the public mind because it comes at a time when mankind is facing the truth that the good life, at least as it is defined in western industrial terms, is not obtained without marked modification of man's physical and social environments. Orange groves are bulldozed to make cities. Fish die in streams polluted with pesticides. The derelict remains of automobiles clutter our landscape, and the air is being loaded almost promiscuously with the waste products of this industrial age.

Our situation is absurd because it is not rational. For the choices of the alternative uses of energy and resources which are part of our technological system, are not, as far as their human outcomes go, based firmly upon science, certainly not upon the science of the eastern dervish who, according to an ancient Arabian tale, admonished his sultan, "Do not begin an act whose end you cannot foresee." The sultan, acting unilaterally, bound by this advice, saved himself from dying as a result of a poisoned lancet in the hand of the plotting grand vizier. No such luck comes to us as members of a community faced with the problems of the air.

And not being able to foresee outcomes, the technological system does not readily detect the points at which the pollution of the air is packed beyond the limits of safety, comfort, and beauty

Our wastes are increasing exponentially along with the growth of wealth and population. Science tells us that in the light of our present knowledge, prediction of the capacity of the atmosphere to accommodate wastes, is an indeterminate problem. Common sense tells us that there are already circumstances under which the capacity is being exceeded.

We come now to some definitions of our problem—definitions which, taken in the large, make it seem in terms of science fairly simple. We start, of course, with the fact that the earth's atmosphere is a gaseous envelope; that its principal constituents, nitrogen and oxygen, account for almost all (21 percent and 78 percent respectively), of the volume of the air; that it has a variable content of water vapor which varies at 100 percent relative humidity from about .01 percent by volume at minus 40 degrees, to about 7 percent at 100 degrees F. Carbon dioxide constitutes only .03 percent by volume, and like oxygen, it is being continuously withdrawn from and added to the atmosphere. But its small relative volume is maintained by virtue of the fact that there is absorbed in the ocean water about a thousand times as much carbon dioxide as occurs in the atmosphere.

This atmosphere is finite. Approximately half of all the air lies within three and a half miles of the earth's surface. Nearly all of the air, and almost all of the cloud formation, is contained within the troposphere, that layer of the atmosphere which extends to an altitude of about ten miles in the tropics and six miles in the temperate zone.

It was in the primeval purity of this tropospheric environment that man's initial evolution took place. Until he discovered fire, the available pure air was for practical purposes unlimited. With the discovery of fire he started the process of air pollution as we now know it—a process which was to accelerate continuously as he learned with increasing efficiency how to release stored energy to modify his own local environment.

All life—not just human life—is characterized by a process of conversion of energy from one form into another. Man perhaps can be distinguished from the animal level by the extent that he deliberately converts this energy by processes outside the limitations of his own body. All energy conversion is accompanied by certain material byproducts. It is the discharge of these byproducts into the air at an ever-increasing rate during the past century which results in the phenomenon of air pollution.

What are these pollutants that result from the conversion of energy under human direction? They can be defined as chemical, biological and economic—chemically, by their composition; biologically, by their interaction on living systems, human and other; and economically, by their social characteristics.

The principal pollutants appear to be inorganic and organic gases and particulate matter. Carbon dioxide and monoxide, sulfur dioxide, some hydrogen sulfide, nitric oxide and dioxide, are the main inorganic gases produced from the combustion of fossil fuels. Also in the category of inorganic gases one must mention hydrogen fluoride, both as an industrial byproduct and as a rocket fuel.

Among the organic gases is ethylene, which, although it arises from industrial sources, has its primary source in automotive exhaust. Of equal importance are the higher numbers of the olefin series which, taken together in the presence of sunlight with other classes of organics, nitrogen dioxide or nitric oxide, result in the complex chemical reaction which has come to be known the world over as "the Los Angeles smog reaction."

The most common particulate matter in cities is that ubiquitous indicator of human existence, dirt. Next most prevalent is soot, finely divided carbon resulting from an inefficient combustion of carbonaceous fuel. Soot carries with it, because of its enormous surface per unit of weight, a load of heavy hydrocarbons of the sort that are found in smoky flames.

Three other classes of particulate matter deserve mention: the economic poisons, radioactive material and pollens. The economic poisons, while primarily nonurban in their use, are often disseminated through the air, finding their way beyond the intended site of application. Airborne radioactive contamination arises from the use of such material in research and in power production, and, of course, from the testing and use of nuclear weapons. In global biological terms this is undoubtedly the pollutant of greatest potential hazard.

It has been estimated that these various pollutants are being released into the air over the United States at a total rate of over 130 million tons annually, or more than half a ton per person per year. When one corrects that concept for the relatively low density of gases, one has some notion of the volume which these substances occupy. Somewhat less than 1 percent of this total is accounted for by pollen, somewhat over 10 percent by industrial dirt and ash, including soot, about 20 percent by natural dust, another 20 percent by sulfur dioxides, and the remainder by all other pollutants.

The sources of the five major pollutants—carbon monoxide, sulfur dioxide, hydrocarbons, oxides of nitrogen, and particulate matter, are estimated in terms of annual production as follows: in first place, come automobiles, trucks and buses, accounting for 85 million tons a year; second, the manufacturing industry, accounting for 22 million tons annually; third, the 15 million tons produced annually by electric power-generating plants; and, finally, the heating of homes and other buildings produces 8 million tons annually.

Described in chemical terms, the major air pollutants arise because of the combustion of fossil fuels. The burning of hydrocarbon fuels in internal combustion engines is the single most important pollutant source. Small wonder, then, that there is a revived interest in the electric-powered automobile.

The biological effects of air pollution range from the explicit to the speculative. A case in point is the difference between the behavior of the oxides of carbon. The toxic effects of carbon monoxide have been known since antiquity. Carbon monoxide begins to be hazardous to humans at a concentration of about 100 ppm if the level is maintained for several hours. That level can be reached in areas where traffic is heavy.

The global increase in concentration of carbon dioxide appears, on the other hand, to have had no direct effect upon living organisms. It is of speculative interest because the ability of the atmosphere to retain heat is increased by increased concentrations of carbon dioxide. Small temperature changes, on the order of a degree, profoundly affect the earth's climate. Hence, this gradual heating up as a result of the increased carbon dioxide from the use of fossil fuels could be an important factor in modifying the ecology of the planet.

Sulfur dioxide, when in the presence of air and water, is an intensely irritating substance at the level of a few parts per million. It is generally believed that sulfur dioxide is a dangerous pollutant. As evidence is the fact that it has been centrally involved in all of the air pollution disasters of recent history. Hydrogen sulfide, on the other hand, seems rarely to reach hazardous concentrations in the open atmosphere.

The oxides of nitrogen, together with hydrocarbons, figure in the complex smog reaction which produces an end product mixture that, in addition to damaging plants in specific ways, also causes irritation to the eyes and mucous membranes of humans and introduces an environmental hazard by reducing visibility. Hydrogen fluoride is extremely toxic to nearly all plants and animals. It creates local problems of pollution when it is produced in the manufacture of phosphate fertilizers, certain iron ores, and in the manufacture of aluminum. It has a potential for much wider distribution in its use as a rocket fuel.

Air pollution tends to be an urban phenomenon. Here the concentration of products from powerplants, industry and automobiles is high. The fall of dirt and soot may exceed a pound per square foot per year.

There has been a particular interest in the health effects of exposure to urban atmospheres. So far evidence is lacking that long continued exposure to low levels of air pollution is having unfavorable effects upon human health. This is the finding of the Environmental Pollution Panel of the President's Science Advisory Committee. They go on to state:

> "Ill effects, if present, must be markedly less noticeable than those associated with cigarette smoking. Attempts to identify possible effects of ordinary urban air pollution on longevity, or on the incidence of serious disease have been inconclusive. Special attention has been focused on lung cancer which is known to be closely associated with tobacco smoking and with the inhalation of radon, radioactive materials, nickel carbonyl, chromates, asbestos and other chemicals.
>
> "There are consistent findings of a greater incidence of lung cancer in cities than in the country, and it is possible that urban air pollution is a contributory factor to the disease."

One important caution is raised by biologists about this kind of negative finding. They point out that all living things are interdependent and interacting, merged into a single dynamic system. Tampering with the system produces many side-effects, some of which can be damaging. Thus the temptation to caution, when the data concerning specific effects on humans, plants, and animals are not, in themselves and in the short run, alarming. Persons who take this view are apt to see in the worldwide data strong evidence that air pollution is associated with a number of respiratory ailments, notably nonspecific respiratory ailments, chronic bronchitis, chronic constrictive ventilating disease, pulmonary emphysema, and bronchial asthma, as well as lung cancer.

Only recently have serious efforts been made to define air pollution in economic terms. Early activities were confined, for the most part, to efforts to determine the external costs of agricultural losses and property values. These are not insignificant. They were considered recently to amount to some $65 per person per year. But as the problem of pollution has been seen more and more to be a problem of air conservation, there has been an increased interest in the application of economic analysis to public policy concerned with air pollution.

In economic terms, air pollution is an external cost generated by production and consumption processes. The goal of economic analysis is to find means so that decisions on how much to produce, and what technologies to employ take proper account of all the costs and benefits arising from the economic activity being examined.

The economic management of air pollution appears to be somewhat analogous to the water pollution problem. This gives rise to the notion of the airshed as analogous to the watershed. For several reasons, however, it is thought that air pollution is more difficult to deal with than the water pollution problem.

First, the evidence linking air pollution to health is somewhat stronger than the evidence so linking water pollution. Second, air pollution is more local than water pollution, and hence requires a heavier burden of control. Third, the meteorological events associated with air pollution are more difficult to control than the hydrological events associated with water pollution, for, while the atmosphere has powerful self-cleansing properties, they are not presently subject to human control. Finally, air pollution can best be controlled at its source while there are alternative ways of dealing with water pollution at a distance.

Thus, in economic terms, despite considerable effort and interest, we are as yet not able to measure the costs of air pollution damage. Cost benefit analysis is difficult here. Nor would economists agree on economic solutions for control. Perhaps they cannot be expected to do so because the criteria which must be taken into account in air pollution control are social, biological and psychological as well as economic.

These, then, are the dimensions of the air pollution problem, dimensions which define the problem in terms that suggest to many that the air is a finite resource in the public domain. In its present state it is a problem derived from the use of fossil and radioactive fuels. Once coal burning furnaces were the great producers of primary pollutants. Now the internal combusion engine is the great producer of both primary and secondary pollutants, and in the future, one may speculate, the greatest hazard may arise from nuclear materials.

Air pollution endangers crops, livestock, and humans. Once emitted into the atmosphere it is almost impossible to control, for its coverage, concentration and dispersion are subject to meteorological forces not under human control. But neither, under present policy, can it be adequately controlled at its source.

If I may depart now from definition to a bit of speculation. It would seem that in the solution of the problems of air pollution, we might apply a concept which is a favorite of John Gardner's—the concept of self-renewal. It would seem that the technology from which air pollution is derived is capable of providing new solutions which in a sense perform a function of self-renewal at the technological level. What seems to be classic in the case of air pollution is that it calls into attention the fact that we do not have a related process for self-renewal for what I think the behavioral scientists are apt to call "social infra-structure."

Let me offer an anecdote that is evidence on this point. A week or so ago, I had lunch with a student who had just returned from

New York City, which was having at that time some difficulty in air pollution. The student was very much interested in the problem of connecting intellect with public policy, and he said he had gone about the streets of New York and talked to a great many people. He had gotten some fairly good definitions of what was going on—definitions of air pollution that would be perhaps consistent with the kind of primer definition which we have used here today. But then he went one step further and asked a lot of people what they thought could be done about it, and he met no one, he said, who had any idea.

It would seem to me that one of the emphases which we need to underscore in searching for solutions or amelioration of the problems of air pollution is a fundamental political and social problem of building infra-structures—building ways in which the values which are held by the person on the street, can in some way be connected with the social and political apparatus which is designed to apply the best science we have at any one point in time. It would seem to me that, defined in these terms, the problem of air pollution is no longer unique.

It is no different, I think, from a set of other human problems in education and health, and maybe even in practical representative politics. If it is true that we are going to function rationally in our western democracy, then it probably becomes necessary to find ways in which the values of the consumer can be confirmed by knowledge and information which he does not possess for himself in a democratic structure which permits public response to his concerns. And it is perfectly clear what the consumer's values are in terms of air pollution. The consumer is almost a fundamentalist on this point. He would like to return to the *status quo ante*.

This is, I think, where one has to start in the building of an infra-structure. I would argue, that our processes for self-renewal and our social and political structures are being called into question in the resolution of this problem.

In this situation of an "absurd crisis" we do not, of course, draw away from rational solutions. We as human beings are conditioned to be optimistic about our ability to use the peculiarly human asset of conceptual thinking. This is an old optimism, not confined to the Western World. It is said, for instance, that a Chinese character which may be read as meaning "crisis," can also be translated to read "opportunity." We will, I suppose, acknowledge the rational as an antidote to the absurd, just as did Camus in the *Myth of Sisyphus*. But even when knowledge and concept fail to produce solutions, we always have the possibility of using political methods to express a priority of values to gain first approximation to the public management of human evolution.

In that sense this conference, which is part of a political process, is crucial. For political process is one mode of achieving moral and ethical judgments. The problem of air conservation as put by the AAAS Commission on Air Conservation, "is to select the appropriate means for either disposing of or using the byproducts and to employ appropriate forms of energy. The definition of such an optimum, the risks we are prepared to take for the benefits we enjoy, is not a matter of scientific judgment, but rather one of moral and ethical judgment."

Mankind must ultimately make a decision. We cannot abandon our technology without relapsing into savagery. But we cannot continue our present course of technological development without the risk of making the earth unfit for human habitation.

". . . physician, professor of medicine, assistant dean of a medical school . . . president of the American Thoracic Society . . . member of the AMA Council on Environmental and Public Health . . ."

AIR POLLUTION AND OUR HEALTH

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In any approach to the problem of air pollution and health, little can be added to the statement of Dr. Frederick Sargent before a symposium on the subject sponsored by the Council of Environmental and Public Health of the American Medical Association. Dr. Sargent stated that the problem is basically an ecological one. He meant that if a biological species survives in an environment in which it happens to be placed, there is a continuous and intricate interchange between that species, all the other varieties of life, and the environment itself.

If we continue this ecological metaphor, we can say that the human species is dependent upon a medium composed of land, water, and atmosphere, in the same sense that a culture of bacteria is dependent upon a medium. Either species, if it is to survive, must find the necessary oxygen, carbon, sulfur, nitrogen, iron, and so on to support its existence. Each species also must eliminate wastes in such a way that their accumulation in the medium will not approach toxic or inhibitory levels. Biologically and ecologically, the problem is as simple—or as infinitely complex—as this.

In this conference, the discussion will deal with only one aspect of human ecology, that of the atmosphere. While such a limitation is permissible, it is logically impossible, since the three elements of the human medium are in a dynamic state of interaction between and among themselves. Substances committed to the atmosphere in time appear in water, then in soil, and then in human food, as studies of nuclear fallout have all too clearly established. There is no reason to suppose that other material in the atmosphere will behave in any other way than the easily traced radioactive substances. Thus pollution of the atmosphere becomes a problem of ecological and biological pollution in general.

It is still possible to discuss atmospheric pollution in its relation to human health in a more restricted fashion, but the discussion must always carry with it the warning that this is only an element in the total problem. All forms of life, not only the human, are involved.

No clear medical definition of human health is available. It is much more than the absence of disease. Any satisfactory definition would have to carry with it some kind of statement in regard to maximal or optimal function. Such a statement would necessarily imply minimal disorder of the functioning unit. I hasten to add that we know next to nothing about these large generalizations; human functions are far too diversified, not only among the species but also in each individual. Disorder, of course, refers to anything from wasted time or effort, through the very human responses of irritation and annoyance, to actual disease, mental or physical.

This audience is far too sophisticated for me to be able to tell you much about the atmosphere. From the standpoint of present discussion it is probably enough to say that while it is huge it is also finite. If we add to this the fact that the available energy per human as well as the number of humans has increased geometrically in the past two centuries, I think we can agree that a point could be reached at which the envelope of gas might be significantly altered in chemical and physical characteristics.

It is probably safe to make such a statement even as we acknowledge that the atmosphere possesses a tremendous capacity of self-purification. Particulates fall out, either as free material or as nuclei of water droplets. Gases adsorb to particulates, dissolve in water or condense and fall out. Atmospheric circulation, of course, under most conditions produces significant dilutional effects, while many microbiological units are destroyed by ultaviolet irradiation. But the same circulation and diffusion that reduce local concentrations carry substances to all parts of the envelope, and the same irradiation that destroys most pathogenic microorganisms produces deleterious photochemical alterations in a number of chemicals. The same water droplet that brings to earth nitrogen oxides or sulfur dioxide also combines with them to produce fogs of sulfurous, sulfuric, or nitric acids.

The increase in available energy per person is mostly accomplished through the production of carbon dioxide. Since the increase in population is geometric and the increase in energy available per person is at an exponentially higher rate than the rate of population change, while any increase in carbon dioxide recycling vegetation is arithmetic—if it increases at all—it is obvious also that at some point there will be a limit to the capacity of the carbon dioxide system and a measurable increase in the amospheric content of that gas. The climatic effects of a change upward of the carbon dioxide content of the atmosphere are roughly predictable and would not meet with unqualified approval. These are some of the more distant features of our ecological headaches.

In the discussion that follows, the facts will be presented as far as I know them. The conclusions I draw from these facts will be as carefully stated as possible. Perhaps you may regard them as overcautious. However, a good cause, the control of air pollution, does not justify, and in the long run is not assisted by, bad science. There are many aspects of the effects of air pollution on health about which we know very little, just as we know very little about the effects on soil and water when pollutants leave the atmosphere and enter these other parts of our medium. It is not enough to suggest that if pollution damages lettuce, it must damage our lungs. That is a statement that calls for proof, and the most certain way to lose a campaign is to support it with statements one cannot verify.

The immediate present is—as might be expected of humans—our concern at this meeting. In general and for the great majority of the population, we are not in bad trouble yet. The episodes of severe pollution that have occurred have been limited in geographic and temporal extent. I refer, of course, to the episodes in London, Donora, Pennsylvania, and Los Angeles, when for periods of several days to a few weeks atmospheric inversion and stagnation resulted in abnormally high and prolonged concentrations of acid oxides. The only reliable measures of the effects on humans were sudden increases in the number of deaths among elderly and sick individuals. The fact that no reliable measures exist for other effects on the populations does not indicate that such effects did not occur.

Indeed, very little is known about the effects of prolonged respiration of irritant gases at low levels of concentration. It certainly seems theoretically possible that persistent and progressive bronchitis could be an expected result. The difficulty in experiments lies in concentration, in quantity, in species difference, and in mucous membrane reaction. These are all variables one must take into account.

Clearly, two problems are involved. The first has to do with the question of whether or not the gas is of a type and at a concentration to produce such acute effects as burning, coughing, increased mucus secretion, or epithelial cellular injury. This question can often be solved by human study, since the exposure will be of short duration. It is not safe, however, to conclude from smarting or watering of the eyes or nose that the bronchi will necessarily respond in the same manner. Even if the bronchi respond with increased mucus production, that result—in its essence a protective and defensive mechanism—will not inevitably signify cellular damage. If the bronchi are already damaged by some other agent, however, the same concentration might have more serious effect.

When one gets to the question of prolonged exposure, say, fifty years, there is almost no reliable method of getting at the answer. Animal exposure studies, even over periods of two or three years, fail to simulate human experience. Since for such experiments it is necessary to deal with populations, most studies have dealt with small animals. Since their respiratory physiology is different from that of man, great caution in extending results of such experiments to conclusions about effects on humans is entirely warranted.

Some studies on human populations indicate a higher frequency of chronic bronchitis in urban and industrial environments than in rural areas. Other types of epidemiological studies likewise point to a relationship between atmospheric pollution and chronic bronchitis. None of these is clearly conclusive, but the trend of all of them is in the same direction. Probably the fault lies in our method of thought. Chronic bronchitis is not a specific, single disease, and it would be naive to suppose that it may have a single causative factor. Bacteria, viruses, chronic infection in the nose and sinuses, may all operate, along with irritant gases, to produce the effect we name as chronic bronchitis. It is clear that better studies are needed. But we may not have time for definitive studies. It is evident that atmopheric pollution is a progressive phenomenon. Its cumulative consequences may be far more important than its causal relationship to a particular set of diseases. It would seem reasonable to undertake correction before a serious ecological disaster could make restoration impossible.

So much for oxidants and acid-forming gases. A significant increase in their concentrations unquestionably has led in several instances to an excess in death rate during the period of high-level pollution, but the excess has consisted of individuals near the limits of respiratory and cardiac reserve. The evidence from human epidemiological studies and from experimental work in animals is not strong enough to warrant the statement that prolonged moderate levels of pollution acting alone produce chronic bronchitis or emphysema. It would be equally fallacious to state that such pollutants do not affect man's respiratory apparatus if exposure persists over a long period of time.

If we turn to consideration of other materials of the atmosphere, Dr. Dixon has mentioned volatile hydrocarbons. One of these, benzo(a)pyrene, specifically appears in the atmosphere and has been shown to produce malignant changes in the skin of experimental animals. These are both facts, but their existence does not permit the logical extrapolation that pollutants of such types produce carcinoma of the lung. It is no more permissible to disregard such a possibility.

One of the major considerations that lead to such continuous caution against lacunae in logic is medical history itself. There was a time when moist evening air appeared to be the cause of malaria. Not any less did the consumption of port wine seem to be the cause of gout. There are plenty of other instances of the fallacy of the obvious coincident.

Other pollutants appear in less widely distributed fashions. Houses on the lee side of stacks may receive excessive concentrations of a considerable variety of industrial emissions such as beryllium, zinc, and so on. But these are nearly always local and limited situations. In the case of possibly more widespread pollution by arsenic, lead, or nickel compounds, a necessary step is to demonstrate that absorption occurs, not that it can or may.

For a nongaseous compound of any kind to have an effect it must either be deposited on the mucous membranes of the bronchi or in the alveoli of the lung, or it must carry with it adsorbed gases that are directly injurious. The deposition of particles is determined within a rather narrow range of diameter. Their retention is determined by the integrity of the structure and function of the membrane on which they are deposited. In other words, lungs and bronchi that are already diseased or damaged behave in a different fashion and retain more particulates for a longer time than do normal structures. Both acute and chronic infections thus play a role, as probably also does the inhalation of tobacco smoke.

Two other rather classic examples of general atmospheric pollution are frequently cited. The first of these is so-called Tokyo-Yokohama asthma, a syndrome of bronchial contraction and irritation resembling true asthma. It has been most frequently noted in association with episodes of intense pollution in the area around the two cities named. The condition has occurred in people who never had asthma before and who apparently have no further attacks after they leave the area. Since the condition does not affect the entire population or even the entire population of American military service families, one is forced to conclude that some additional factors are required to cause the appearance of symptoms in specific individuals.

Closely related to Tokyo-Yokohama asthma are the observations in New Orleans. There it was noted that when prevailing breezes carried material from burning trash dumps across the city, the number of calls of asthma patients to an emergency room underwent a marked increase. However, the patients were all already known as asthmatics of long standing, unlike the Americans in Japan. Of course, it by no means is exceptional for attacks of asthma to be precipitated by many different stimuli. What one seems to find in these two instances are heavy atmospheric pollution and other changes in atmospheric conditions that lead on the one hand to bronchospasm in otherwise healthy people and on the other hand to precipitation of bronchospasm in people in whom that reaction has become established. Differences may lie largely in the intensity of the stimulus.

I have intentionally avoided the question of individual air pollution, the worst and most concentrated form of which is the inhalation of tobacco smoke. That is another subject. Nor have I turned my attention to the air as a medium for the dispersal of innumerable pathogenic organisms, which it most certainly is. In terms of bacteria and viruses, the air in this room is probably contaminated to a degree that one would never allow in a public water supply.

I hope these remarks will not be interpreted to suggest that I favor atmospheric pollution. Rather, they signify a very earnest desire to be certain that reasonable demands for clean air should not be supported by illogic or specious argument. It does not seem possible to say that atmospheric pollution produces chronic bronchitis, emphysema, asthma or cancer. But there is no doubt that periods of high pollution and prolonged stagnation aggravate the first three conditions and shorten the lives of people with bronchitis and emphysema. Equally certainly, such atmospheric episodes initiate and exacerbate asthmatic attacks.

For those of us who are so fortunate as not to fall into any of the categories mentioned, it is enough to return to the original definition of health. If the condition of the air is such as to annoy and irritate us, to reduce our performances from their maxima, it is unhealthful.

At this point I return to the original ecological consideration. The waste products of the metabolism of an industrial society can poison the medium on which it exists. Discharge of gases and solids into the atmosphere is a part of this metabolic waste. We must weigh carefully the effects of these materials not only as they apply directly to human disease, discomfort, or irritation but also as they affect the environment on which we are dependent for survival. We possess the productive capacity to render this planet incapable of supporting human life at its present level. Our medium of land, water, aind air can tolerate only a certain amount of damage. Until we know—and very accurately know—the tolerances of this medium, we should be guilty of the blindest folly not to safeguard it with as much ingenuity as we apply to problems of production. The control of waste emissions into the atmosphere is one means of assuring ourselves that we shall not render our medium inhospitable to human survival.

Much the most important argument for control of air pollution, therefore, is not related to watery eyes or dirty clothing, annoying as these may be. Nor is it to attacks of asthma or chronic bronchitis. It is the argument that we may not be able to survive beyond certain levels of non-radioactive pollution of the atmosphere.

". . . scientist and educator . . . former dean of engineering and architecture, now university president . . . advisor to National Research Council, National Science Foundation . . . President of National Academy of Engineering . . ."

AIR POLLUTION AND OUR TECHNOLOGY

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When I was asked to speak to this group, I thought that this would be a golden opportunity to rise to the defense of the engineers, because there are many people who feel that if the engineers did their job and designed equipment properly for precipitators, steel mills, and engines, we would have no pollution problem. But it isn't that simple. Many engineers today are getting sensitized to the fact that when we have technological triumphs (orbiting the moon or discovering a laser or finding out about DNA) they are great scientific triumphs. However, when we have a northeast power blackout or disastrous floods in Florence—or the air pollution problem—these are engineering failures.

Neither the engineers nor the scientists nor the humanists nor the social scientists can, by themselves, solve this problem of air pollution. I suspect that a social historian of the future, faced with the task of trying to find out the most significant intellectual development of the second half of this century, might decide that our most important contribution to the general growth of human progress was our growing awareness of the interdependence of all human knowledge. I doubt if there is any more significant development of our times than our relatively recent realization that the future of our complex civilization depends not so much upon the independent advances in the diverse fields of human activity as it does upon our ability to integrate our knowledge and to apply it in a systematic and coordinated fashion to all the problems of modern life.

Man throughout history has sought to increase his knowledge of the natural forces at work in his environment and to use this knowledge in a sort of engineering way to satisfy his desire for a richer and a fuller life. The scientific discoveries and technological developments of the past have gradually freed the individual from the need of personally seeking the means of meeting his own basic requirements for food and clothing and shelter. For centuries, the trend has been toward a division of labor, toward continually increasing specialization, toward a departmentalization of the knowledge that has been accumulated. In the traditional disciplines and subdivisions of human activity, we have tended to work independently, with little thought of the effects of our labors on other areas of human endeavor. Even within separate disciplines, there has been a trend toward separation and isolation as knowledge and technology have grown. Civil engineers, for instance, as opposed to military engineers, for centuries took care of our technological needs. But they have, over the years, found it necessary to branch out into specialized fields, like electrical engineering, mining engineering, sanitary engineering, and even aerospace and nuclear engineering. In medicine, the general practitioner has given way to a variety of specialists, and the process is carried out in almost every field of endeavor.

The story is told of a young man who was discussing with the old family doctor his plans to study medicine. "I suppose you're going to specialize," said the doctor, "well, the ear, nose, and throat field needs good men." "Oh, that's too broad a field," the young man answered. "I'm going to specialize in diseases of the ear." "Really?" said the old timer. "Which ear, right or left?"

Yet in almost every field of human endeavor, this process of increasing specialization has been a practical necessity in our efforts to keep pace with the accelerating growth of knowledge. Without it we could not have developed the technological competence which characterizes our civilization. But it has also had some serious disadvantages. It has produced artificial barriers between our common efforts toward a better life. The physical scientist speaks a different language from that of the social scientist, and both find it hard to understand the goals and objectives of the humanist or the politician. Indeed, as all of you know, a few years ago, the British scientist, Sir Charles Snow, was very much concerned with this matter. He believed that a serious gulf existed between our scientists on the one hand and our humanists and political leaders on the other, and he warned that this inability to communicate might prove disastrous to both groups. He even deplored the gap which he believed existed between the research scientist and the engineer.

Yet I think Sir Charles failed to take into account a very important trend which has been making itself felt for the past decade or so—a trend which may well turn out to be our most significant contribution to man's intellectual development. I think we have begun to learn the real advantage of crossing formerly rigid lines of the separate disciplines and to approach our problems in the light of their implications and their effects on the total social structure. Certainly it is evident that the physical scientist, the social scientist, and even the administrator have learned the advantages of using the special skills and expertise of the statistician and the programmer of computers. The archeologist has learned that the physicist and chemist can use their special knowledge to help him unlock the secrets of dating long-buried artifacts and human remains. Indeed, whole areas have sprung up which straddle the traditional disciplines, like biophysics, biochemistry, and medical engineering. One of the current problems facing most university administrators today is that of providing for the management of interdisciplinary research and teaching programs that cross the traditional lines of university organization.

Terms like human development, regional analysis, water resources, space science, urban redevelopment, community relations, and many others recognize this growing trend. More and more we find ourselves called upon to draw upon the resources of a wide variety of traditional specialties in order to solve the large-scale problems of modern life. The programs and whole science of operations research or systems analysis is an indication of how conscious we have become of the need for combined and integrated efforts in facing these needs of the future.

Yet, in spite of our efforts and accomplishments along these lines, we have not yet been very successful in applying this method to the very large-scale socio-technological problems of our times. Problems like high-speed mass transportation, water retrieval, the disposal of sewage and solid wastes, and similar problems, involving not only technical expertise but also a wide range of social, political, and economic considerations—such problems demand the kind of approach that we are only beginning to apply with any real competence. And perhaps, of all the problems that fall into this category, none is more complex or more widespread and of more importance in terms of our future than that of air pollution.

The simple fact is that the control of air pollution, at the present moment in history, is not basically a technological problem—at least in the traditional sense. I do not mean to imply that we have mastered the technology involved or that we have found all the technical answers we need even to free our atmosphere of the grossest types of contamination. Far from it. Yet, in terms of our understanding of the basic causes of the difficulty and of the technical measures that can be effective in overcoming it, I think it is fair to say that the technology of air pollution control—the state of the art—is in fairly respectable shape.

We know, in a practical sense, and with a reasonable degree of certainty, where the most noxious of the common air pollutants are coming from. We have at least a gross understanding of the dangers to life and property that can result from serious pollution. We have a basic knowledge of the meteorological aspects of the problem. And we have the evidence of cities like Los Angeles and Pittsburgh to indicate that the application of properly designed control measures can bring a reasonable degree of local abatement. In short, from the point of view of technology, we have enough knowledge about the causes and consequences of the problem to understand what can be done, where more research is needed, and what kind of knowledge can be helpful in the design of devices and equipment to do the job.

I do not mean to imply, of course, that there should be any slowing down of our research and development efforts on the technical aspects of the problem. On the contrary, I think that the knowledge we already have is an obvious spur to a more vigorous attack. We realize that we are dealing with a dynamic situation, a situation that will continue to demand increased efforts on all fronts.

We know that continued and extended research is going to be needed simply to keep up with increasing pollution load—the load we must expect from normal growth. We can assume that, with the increase in population, there will be an accompanying increase in industrial and commercial activity, in transportation, and in urban concentration and expansion. Moreover, with the demand for continually higher standards of living all over the world, we know that there is likely to be even greater growth in these areas, and that better technical means of solving the resulting pollution problems must be developed.

Some idea of the magnitude of the problem we are likely to face in this respect is found in the recent report of an advisory panel on the adequacy of technology for pollution abatement which was made for the House Committee on Science and Astronautics. The panel pointed out that the noxious emissions from motor vehicles, even if all of them were equipped with present-known devices for suppression, would rise, by the end of the century, to a level equal to the 1965 rate, when no suppression was employed.

Beyond this, we are going to need continuing research to take care of the changes we must expect in industrial development, as the result of newly developed processes, the changing availability of different kinds of fuel, and so on. If we can reasonably look forward to the gradual elimination of the pollution problem in some areas, we must also expect the problem to grow in others, or completely new problems to develop.

Certainly one of the areas in which research can be beneficial is that involving cost. We need cheaper equipment and cheaper methods of control. Even if we assume that our present technology can produce devices that are economically feasible, cheaper methods will always be desirable and, indeed, may be essential for continued economic growth.

We need more knowledge, too, about the long-range effects of pollution, not only on human health, but also on vegetation, domestic and wild animals, and materials. We lack information, for example, on the physiological response of man to long-term, low-level exposures, and we have much to learn about the effect of pollutants on the ecological balance in nonurban areas.

There is still much work to be done on the basic problem of defining the extent of the pollution problem we face. Although we have had a great deal of experience in what might be called our piecemeal approach to the problem, we are still unable to agree on meaningful criteria and standards that can be universally applied. We need to define such specifications for our air environment, not only in terms of the sources, types, and concentration of the pollutants that are emitted into it, but also in terms of the underlying features of their transport. We need much more information on the effects of atmospheric dispersion and on the reactions and interactions of pollutants during the dispersion period. For this we must have better equipment for sampling, for measuring and analysis, not only at ground level, but also at other levels through the use of portable towers and airborne devices. We need to develop methods for instantaneous detection and sampling, and to work out techniques for operations over large areas.

Clearly, continued and expanded research on the technological aspects of air pollution will be needed for a long time to come. Yet, having said all this, I want to repeat the statement that I made a moment ago—that the basic problem in air pollution control is not a technological one. Not only do we have a good many years of practical experience to draw on, but I think there is every reason to expect that our scientists and engineers will more than keep pace with the nontechnical developments in the field. In a number of universities throughout the country, my own included, the problem is recognized, the objectives are understood, and research programs are under way. And even if "participation by private industry," as the Wolman Report points out, "is very limited," it seems to me that the real difficulty here is a matter of incentive or a matter of cost rather than lack of technical competence.

I think there is evidence that the seriousness of some aspects of the problem, at least, are being more generally recognized. Recent reports from the Ford Motor Company and General Motors about their research on the development of light-weight batteries to power electric automobiles is an indication, if nothing else, of their growing recognition of the pressure on the part of our lawmakers and the general public for a broader and more stringent attack on this part of the problem.

The real difficulty, it seems to me, is not that our technology is seriously deficient, or that it is unlikely to keep pace with the growing problem, but that our efforts to control air pollution have, up to now, been very largely piecemeal efforts. In spite of our long-standing concern with the various aspects of the problem, we have for the most part attacked it in terms of a single industry, or a single source of pollution such as domestic incinerators or the fumes from automobiles and trucks. And even where we have attacked the problem on a community-wide basis, we have been hampered by legal and political complications, and the extent of our efforts has been curtailed by municipal, or county, or township boundaries. The unfortunate consequences of this sort of approach are well illustrated in a distressingly ironic comment which appeared recently in the *New York Times*. The article is very brief but its implications are tremendous. Let me quote the article in full.

> "Cincinnati, October 25—Cincinnati celebrated the opening of 'Clean Air Week' Monday with a day and night of smog, the worst in its history. A choking, acrid vapor swept into the city from adjoining counties."

That's the complete report.

It seems to me that the problem we really face is a problem of integrating our attack, of coordinating our efforts, of pulling together the knowledge we have gained, and are gaining, of the factors involved—in all their diversity and complexity—and then applying to the whole situation the kind of broad interdisciplinary approach that has characterized the development of our best technological efforts in the past few decades. We have done it in war systems, and we can do it in something like this. But it will not be an easy job. I doubt if any of the large-scale problems we have faced in recent times, including that of putting astronauts into space, has presented us with so great a challenge as that of air pollution.

Air pollution control demands our highest levels of scientific and engineering skill in a wide range of technical areas. But beyond this it involves an even wider range of political, legal, and economic considerations which impinge upon long-standing customs and practices and which are entangled with the most deep-seated forces in our social structure.

We must, somehow, achieve a fundamental change in attitude—a whole new point of view toward this situation of air pollution. We must realize that clean air, and for that matter clean water and all the other benefits of the natural world, belong to everyone, and that nobody has the right to destroy them. And we must find practical ways of regulating our conduct so that this new concept becomes a basic force in every aspect of our social and economic development. This is going to involve some radical shifts in the way we do things.

Under our present system, the man who neglects this responsibility, or who refuses to accept it, is actually rewarded—in the sense that he can make his product or provide his services without the added cost of antipollution measures. And his competitor, the enlightened, public-spirited manufacturer or industrialist, is penalized accordingly. As long as our attack on the problem is piecemeal, as long as our legislation is concerned with local conditions, this situation will continue to exist.

What we need is a judicious system for rewarding those who use technology to produce the best possible product or service at the least possible cost—but who do it without destroying the natural benefits which rightfully belong to all of us—the air, the water, and the open spaces that constitute our mutual environment. The approach we make must be industrywide and nationwide, and comprehensive in nature. There is little to be gained if we succeed in eliminating the dust from a cement plant only to have it replaced by the oil fumes from a bituminous concrete plant. However we accomplish the end—through tax benefits or some other method—we can do it only through a coordinated, integrated method of rewarding the conformist and penalizing the irresponsible.

As a beginning, there are, I think, three aspects of the problem which demand immediate attention. First, we must exert every possible effort to develop better channels of communication among all those who have some part to play in a coordinated attack on the problem. In the sphere of technology, this means better and quicker transfer of knowledge between the physical scientist and the engineer who must make the practical applications of the newly discovered information. It means more adequate understanding among the biologists and physicians and chemists and meteorologists and agriculturalists involved. But more than this, the problem demands a new kind of communication between all these people on the one hand and our political, legislative, and administrative leaders on the other—a kind of communication which, on this scale I'm sure, has never been achieved before.

Second, I think we must undertake an extensive and intensive program of public education. Certainly, without public awareness of the life-and-death nature of the problem, any attack we attempt will be severely hampered if not impossible of completion, And if, in the process, we encounter continued apathy or evasion on the part of those whose whole-hearted cooperation is needed, then it seems to me we must resort to legislative measures to gain compliance. In either case, we must rely not on prejudice and personal judgment, but upon criteria and standards that are based on accurate measurements and rational understanding that our technology can now—or will soon be able to—provide.

And finally—and most important—we must extend and develop our techniques for systems management so that they can be effectively applied to the problem of air pollution. We must make use of every available development in this area. And here again let me say that to the extent to which social and legal and political inputs to the problem are involved we are presented with an unprecedented challenge.

On all three of these counts, it seems to me that this conference is a real start in the right direction. A gathering of this type should provide, if nothing else, an awareness of the complexity of the problem we face, and understanding of its vast and serious implications, and an incentive toward the kind of cooperative effort without which the problem cannot be solved.

". . . leader in labor and consumer affairs . . . for two years Special Assistant to President Johnson for Consumer Interests . . . since 1961 Assistant Secretary of Labor for Labor Standards . . . guardian of the American consumer . . ."

AIR POLLUTION AND OUR WELFARE

ESTHER PETERSON
Assistant Secretary of Labor

I come before you, not as an expert, but as one who would like to discuss the question of air pollution in nontechnical terms, knowing the need, of course, for factual information. I hope I can qualify as being sensitive to the expression of citizens in this area, as in many others.

In recent years I have become somewhat closely identified with the Nation's housewives—indeed more closely in recent months that some executives would like. In this role, I am constantly asked by male directors of business enterprises: "Mrs. Peterson, what do women want?"

O. Henry had the answer in one of his splendid short stories. He said: "What a woman wants is what you are out of. She wants more of a thing when it is scarce."

Since our subject here today is clean air, what answer could be more appropriate? Women are finding clean air more scarce and they want more of it.

But women are not my only concern. When I wear my "consumer hat," my concern embraces all Americans: men, women, children. And it involves the very broad range of things that we consume, from food and water to television programs and polluted air. Consumer issues often affect the very quality of life itself. This is particularly true of air pollution.

If you ask any intelligent American about his views on air pollution, you are likely to find—as a recent poll showed—that he is quite concerned and he thinks that more should be done about it. You will also find that he has little knowledge of the ways air pollution is affecting his life or the toll it is exacting from all of us. In my opinion, this makes it important that the relatively few people who do know what air pollution is doing speak out strongly and help the public understand the scope of the problem. In this context, I would like to discuss air pollution as it strikes at three important aspects of our personal welfare as consumers: (1) the price we pay for things; (2) the quality of our existence; and (3) briefly, our health.

First, let us take the economic cost of air pollution. It occurs almost everywhere. It enters into what we pay for food, for house maintenance, automobile upkeep, and laundry. It becomes a hidden price in many other things, including the cost of cleaning up the air.

The total cost is in billions of dollars each year. The figure that is used most often is about $12 billion or $65 a year for each person. One expert calculates that a family of four in New York directly and indirectly spends as much as $800 to clean up the damage and dirt left by the air pollution and what it costs in an indirect way. Others say that the figure is close to $200. We don't know exactly, but we do know it costs.

Take, for example, one of the major purchases a family makes during a lifetime—his home and land. Air pollution discolors the paint, it corrodes the metal and disfigures stone. It shrivels the shrubs and kills flowers and trees. The result can be lower property values, deteriorated neighborhoods, and less attractive communities.

Dirty cities, in turn, alienate potential residents, tourists, and industries. Civic buildings become eyesores. New York's City Hall, London's Houses of Parliament, even our own White House, are examples of the important buildings affected, damaged or discolored to different degrees by dirty air.

Exhaust from motor vehicles and smoke from chimneys also represent waste. They are evidence of incomplete combustion. This waste of fuel alone runs into billions of dollars.

Another hidden cost comes from having to substitute expensive materials that are resistant to pollutants for cheaper materials that would be satisfactory in clean air. I am informed that electricity and telephone costs are generally higher because of the corrosion of electrical contact points by air pollution. As technology advances, sensitive and expensive instruments and equipment must be guarded against pollutants and dust in an atmosphere that is increasingly polluted and dusty. These are costs of concern to consumers.

Both producers and consumers suffer when air pollution kills crops and damages the food for livestock. Damage to vegetation seems to be spreading rapidly. In California, for example, 11,000 square miles of farmland were reported damaged by impure air. This is a serious matter when we realize that, in some 50 years, American agriculture must feed twice as many people from a land area that is steadily shrinking in size as acreage is diverted to roads, parking lots, and factories.

As you know, we rely on vegetation to conserve water; we depend on forests for fiber, for timber and for recreational uses. Since we need *more* recreation areas, *more* parks, and *more* greenery, the costs of air pollution in this area are certainly serious. There are too many multiple and serious impacts by air pollution on our economic welfare. Pollution weakens fabrics from the awnings over the patio to the nylon stockings on a lady's legs. Pollution deteriorates paper, metal, leather, rubber, paint, stone, and glass. The list is awesome. Polluted air eats away the finish on the family car, attacks the tires, the seals, and corrodes the metal trim. The process of removing dirt is often costly, but the cost involves more than money. It goes right to the quality of life. As the urban planner, C. A. Doxiadis, has said, "If our air is polluted, we cannot hope to have a normal life."

Back in 1927, a Public Health Service study in New York City showed that the loss of light due to smoke was sometimes more than 50 percent. Throughout the year, almost a quarter of the precious sunlight was blocked by smoke. The resulting gloom and depression and ugliness and, of course, the increase in light bills and the fact that it makes transportation hazardous, are factors for us to consider.

Wastes discarded into the air may even alter the climate. The Weather Bureau tells us that in winter there is 100 percent more fog in a city than in a rural environment. Studies show that dust particles are many times greater in urban areas, as are the levels of carbon monoxide.

And to go out for a walk can become, as we are told by Tom Lehrer, a disconcerting experience. You all know his record:

"Just go out for a breath of air
  And you'll be ready for Medicare.
The city streets are really quite a thrill,
  If the hoods don't get you, the monoxide will."

We get this point of view not only in our cartoons and in the humor that runs through our society, but seriously, as when President Johnson in his address to Congress on natural beauty, said, "Air pollution is no longer confined to isolated places. This generation has altered the composition of the atmosphere on a global scale." As he said, "Pollution destroys beauty."

Our esthetic senses are affronted by gloom, by eye-stinging smog and by nauseating odors. In many places we have lost our blue skies, our view of lovely scenes, and the purity of the air we draw into our lungs.

This brings us to perhaps the most difficult problem of all—the adverse effects of pollution on our health and safety.

Reduced visibility undoubtedly helps cause delay in ground and air transportation. It also causes accidents. Automobile accidents directly related to air pollution have been documented recently by Pennsylvania, New Jersey, and Louisiana. Obstruction to vision caused by air pollution is said to have contributed to six aircraft crashes in one year.

Even more significant is the contribution of dirty air to the rising incidence of chronic respiratory diseases. The report of the health panel of the 1962 National Conference on Air Pollution was positive on this point. "The evidence," it concluded, "that air pollution contributes to the pathogenesis of chronic respiratory diseases is overwhelming."

Air pollution has been linked to deaths in Pennsylvania and in London. New York City and other east coast cities apparently had a narrow escape only last Thanksgiving Day when an atmospheric inversion caused abnormal pollution. Fortunately, this inversion occurred on a holiday when traffic and business activity were less than on a normal weekday, and fortunately rain intervened. So-called "routine" levels of air pollution can make the difference between minor irritations and serious discomfort to people suffering from asthma, emphysema, or acute bronchitis.

There are those who claim that the cost of pollution-induced illnesses, including absence from work, may constitute the most significant economic loss of all. But even if we could approximate this cost, is there any price tag large enough to put on the health of our people?

The toll that pollution takes on our pocketbook, our health and the very quality of our lives makes one wonder why we Americans don't have a keener sense of the need to protect ourselves. The total cost of all local control programs is estimated at only 15 cents per person a year. This is certainly not much when compared to the estimated cost of $65 per person a year for the damage.

Let's not fool ourselves either as to who pays the bill. Whether it is the cost of air pollution or the cost of fighting it, it's the public—the consumer—who pays. Whether the final bill is rendered in the form of higher taxes or higher prices, it's the public who picks up the tab. I am not amused by economic arguments that skirt this reality. I believe that if the American people knew what air pollution is already doing to them, they would be glad to pay the price for control. Clean air would be a bargain at almost any cost.

Adequate control of air pollution could reduce serious health hazards and bring longer life and greater vitality to many people. Cleaner air could help prevent illness and alleviate the sufferings of those already afflicted.

Adequate controls could result in cleaner homes, more attractive public housing and buildings, better recreational facilities, healthier crops and flowers, greater pride in our neighborhoods, and greater enjoyment of life. Cleaner air could open our view of blue skies and of too many horizons now shrouded in smog; it could pierce the gloom that smothers many of our cities.

Is it too fanciful to think that our cities might be transformed as we learn to design them with air pollution controls in mind, along with the many other factors that are important? Green belts have been suggested for the cities of the future, to isolate industrial areas—couldn't they harbor playgrounds and picnic areas? City patterns and modes of transportation could be planned so as to reduce pollutants, and, at the same time, give us some fringe benefits. Tackling the transportation problem might result in designing cars that are safer, both for the community and for the commuter. This might give us mass transportation which would move us more quickly and safely, reduce parking problems, and unclog our city streets, as well as clean the air.

The question really is, "How do we get from here to there?" With regard to the air, how do we get from a situation in which air pollution is a major national problem to a situation in which we have the clean air we want and need?

There are many ways to answer that question and each of us will tend to emphasize the approach that we know best from our own background and experience. And it will take the combined experiences and backgrounds of all of us, I think, to really get at the solution. Therefore, I see air pollution having many of the characteristics of other problems affecting the consumer and requiring, perhaps, some of the same kind of actions. As President Johnson said in his consumer message to Congress last March:

> "Every domestic program of the Federal Government in a very real sense is directed toward the consumer. When we work to stem pollution, improve transportation, or rebuild our cities, we promote the welfare of the American consumer."

Air pollution reminds me of other problems I have seen consumers tackle for their own self-protection. It is axiomatic that we live in an era when technological change has frequently taken place without full regard for the consumer. The marketplace and the total environment have become increasingly complex, making it difficult for the individual consumer to comprehend what exactly he is up against. However, I have seen persistence and willpower make the most complex reasoning tumble into simple common sense when some of our consumers get to work.

Like most consumer problems, this one is largely economic. Pollution controls cost money, and lots of it. At all government levels, air pollution must compete with a host of other problems for a share of available funds. This is true in the private sector as well. Major segments of industry are reluctant to invest sums for equipment for which, in most cases, no competitive advantages can be expected. We must explore means to help in this area.

The consumer has begun to learn that he does have recourse and that it depends on his own interest and initiative as a private citizen.

Consumers are beginning to realize more and more that business and government respond to pressure—pressure brought by responsible people with a strong case that is well documented. The key is organization.

Citizens have organized into groups across the country to protest the state of our air and water, the level of food prices, and the cost of promotional gimmicks, and in many cases, they have gotten results. In New York City six angry young women were instrumental in the passage of tough new air pollution controls. In Seattle, 40 families succeeded in blocking a big development that they said would have threatened the purity of water for 20,000 people. It is clear that American consumers are awakening to the power they have in organized action.

Many consumer groups are adding air pollution to their programs for action. Last week, the head of a consumer group urged a meeting of state consumer leaders to do just that. I heartily agree with that advice. For as Russell Train of the Conservation Foundation has said, "It is going to take tremendous, continuing pressure by citizens to achieve real improvement."

The problem of air pollution cuts across all four of the basic consumer rights which were expressed by President Kennedy in 1962:

First of all is the right to safety. If impairment of our health alone were the only price we had to pay for pollution, it would be sufficient reason to "control now, for clean air."

Second is the right to be informed. The right to have information and the need to have research and studies to secure correct information are unquestioned, but people must be told how serious the problem of air pollution is. They must have the facts. Information is the prerequisite to intelligent action, especially since much of our modern air pollution is invisible.

Third is the right to choose. It is our task to identify the alternatives so that costs and benefits can be clearly seen.

And, finally, the last right that President Kennedy enumerated, the right to be heard. I believe the American people are in a mood to exercise this right in loud and clear tones.

The more we talk about controlling manmade haze, the clearer becomes the need for citizen action. If it is a matter of getting legislators to appropriate more funds and endorse stronger measures, if it is a matter of getting government and business to use the technology they already have, or if it is a matter of conducting more research, the problem always seems to boil down to the need for getting more interest and support from the general public.

In this country, we have seen many occasions where aroused citizens have banded together to get action for the good of all. It is the democratic way and it is the best way.

Much can come from a conference like this. We can learn from one another. We can identify the problems more precisely. We can indicate priorities. We can even indicate courses of action.

But the greatest contribution will be the ultimate effect on the general public. For few of these efforts will bring results without the help of better informed citizens, more concerned citizens, who are organized for cleaner air. It is high time for all consumers to speak up about the air they breathe.

QUESTIONS AND COMMENTS

BOYD WELIN (*Mayor of Pasadena, California*): The people on the west coast have long been aware of the problems of smog and its side effects. The air pollution control people have done a creditable job in spite of the lack of sufficient staff and funds with which to effectively attack all elements of air pollution. Our Nation is beginning collectively to recognize the seriousness of this very real health hazard. It is not only detrimental to the physical well-being of our communities but also to their economic well-being. Our major metropolitan areas are fast becoming akin to the inside of an old incinerator. If we do not commit all of our available resources at Federal, State, county, and city levels to the eventual solution of this problem, we must suffer dire consequences.

By continued coverage through the public information media, we are highlighting the deficiencies of our progress, which in many respects has been substantial. By this, I mean that we have made headway and, without certain restrictive measures which have been put into effect, the smog problem would in my opinion have been much greater and more serious than it is today.

However, we are not gaining on the problem to the point where we can see eventual elimination of this hazard. In fact, we are running fast just to keep up. I do not profess to be an authority on the causes of air pollution and the remedies. However, I've been a lifelong resident of southern California and from visual observation can attest to the increasing seriousness of the problem.

Much has been done in our area for water pollution. Our sanitation problems have been solved, but it is time now that the other vital ingredient necessary to sustain human life be given top priority. I refer, of course, to clean air.

Unfortunately, I seem to get the feeling from the public that we as public officials have not given the problem our full attention, but have been involved in sort of a lip-service program. It has been my impression that, although people are concerned about smog, they are almost resigned to the idea that, like the weather, one can complain about smog, but nothing can really be done about it.

They feel that getting stirred up about the problem is useless. When they read that a committee, a conference, or an official is going to investigate, discuss, or try to do something about air pollution, they don't believe much will come from it. They have the idea that all this is talk and nothing much more than that.

The man on the street is becoming more and more convinced that politics will prevent a solution to the air pollution problem.

I wish, as a casual but thoughtful observer, to bring to your attention the matter of a possible pollutant which is rarely mentioned. I refer to the microfine powdered rubber which is worn off the tires of our cars, trucks, and buses. With over 3,000,000 registered vehicles in Los Angeles County, it has been estimated that the amount of powdered rubber accumulated in a year would cover a football field 20 feet deep. A possible solution to this particular problem might lie in some type of street and highway flushing on a periodic basis.

The foregoing comments are for the good of the order. They are sound and urgent . . . and also pessimistic. I must insist that they also happen to be correct. We must not allow ourselves to reach the point of no return, at which drastic remedial efforts would be called for which would adversely affect our industrial, commercial, and residential complexes.

The time for positive action is now. We hope that, as a result of this conference, the proper authorities will introduce appropriate legislation on this subject and that adequate research will be carried on at this time.

CARLTON WHITEHEAD (*Vice Chairman, Air Quality Control Committee, Portland, Oregon*): We all recognize the impact that air pollution has on all aspects of our lives. Unfortunately, but not unreasonably, it seems to me we tend to focus almost exclusively on those problems that are most immediate and most important to us at this moment. I wonder if in terms of long-range programs it would not be desirable and feasible to adopt as a policy that *any* pollution, *any time and any place,* is indefensible, recognizing that it is almost certain that this pollution will inevitably become a problem in due time. It seems to me that, unless we take this longer perspective, we're going to be increasingly like the White Queen, who runs as hard as she can just to stay where she is.

CARL E. MOORE (*Professor of Chemistry, Loyola University, Chicago*): I find myself pretty much in agreement with the last comment. May I say a word or two about long-range planning in this overall picture.

In listening to the speakers and reading in the literature about the various things that are occurring today in the field of air pollution, I think that we are very interested in treating the sick patient, but we're not doing very much to immunize the well.

I am referring to the rapidly expanding small communities which are desperately searching for guidance in air pollution control methods. Somebody should come forward and help these people set up control programs to prevent the very things that have already happened in the numerous metropolitan areas that we've talked about today.

I suggest that perhaps two types of objectives ought to be considered by this conference: One is the short-range objective which is, obviously, curing the sick patient; and the other is the long-range objective—how can we keep the patient from getting sick?

STERLING A. TAYLOR (*Department of Soils and Meteorology, Utah State University*): For nearly 20 years, I have devoted most of my time to studying the influence of microenvironment and microclimate on biological organisms, primarily plants. I propose that this conference can do something specific to clear the atmosphere—at least, on a microscale. I ask a question. Can the National Conference on Air Pollution begin its air pollution program by having clean air in its conference rooms?

This morning, Vice President Humphrey said, in essence, that above all a man has the right to fresh air to breathe. Can anyone in this country, or out, take the proceedings of this conference seriously if it does not, at least, take the first step to clear up the air in our own conference rooms? There may be pathogenic organisms and viruses in our rooms, as suggested by Dr. Chapman; however, tobacco smoke is generally the most irritating pollutant.

Again, Dr. Chapman stated that the inhalation of tobacco smoke is the worst and most concentrated form of individual air pollution. Apparently, his speech had an effect, because I have noticed that a number of people in this group agree with me. According to my observation, the density of the smoke in the atmosphere in this room has steadily decreased this afternoon.

Many people have told me that they are unable to give their best thought or to perform to a maximum in smoke-filled rooms. Although pollution of our air—the outdoor air—has, upon occasion, reached serious proportions, nowhere have I personally experienced more irritation than in the microatmosphere of smoke-filled conference rooms.

Operators of most hotels and public buildings have taken steps to install filters and ventilating systems. These, however, are not sufficient to keep the air clean. Neither do laws and ordinances offer very much promise. The real solution lies in the determination and good will of the participants in conferences. Dr. Walker said we need somehow to achieve a fundamental change in attitude, a whole new point of view toward this situation.

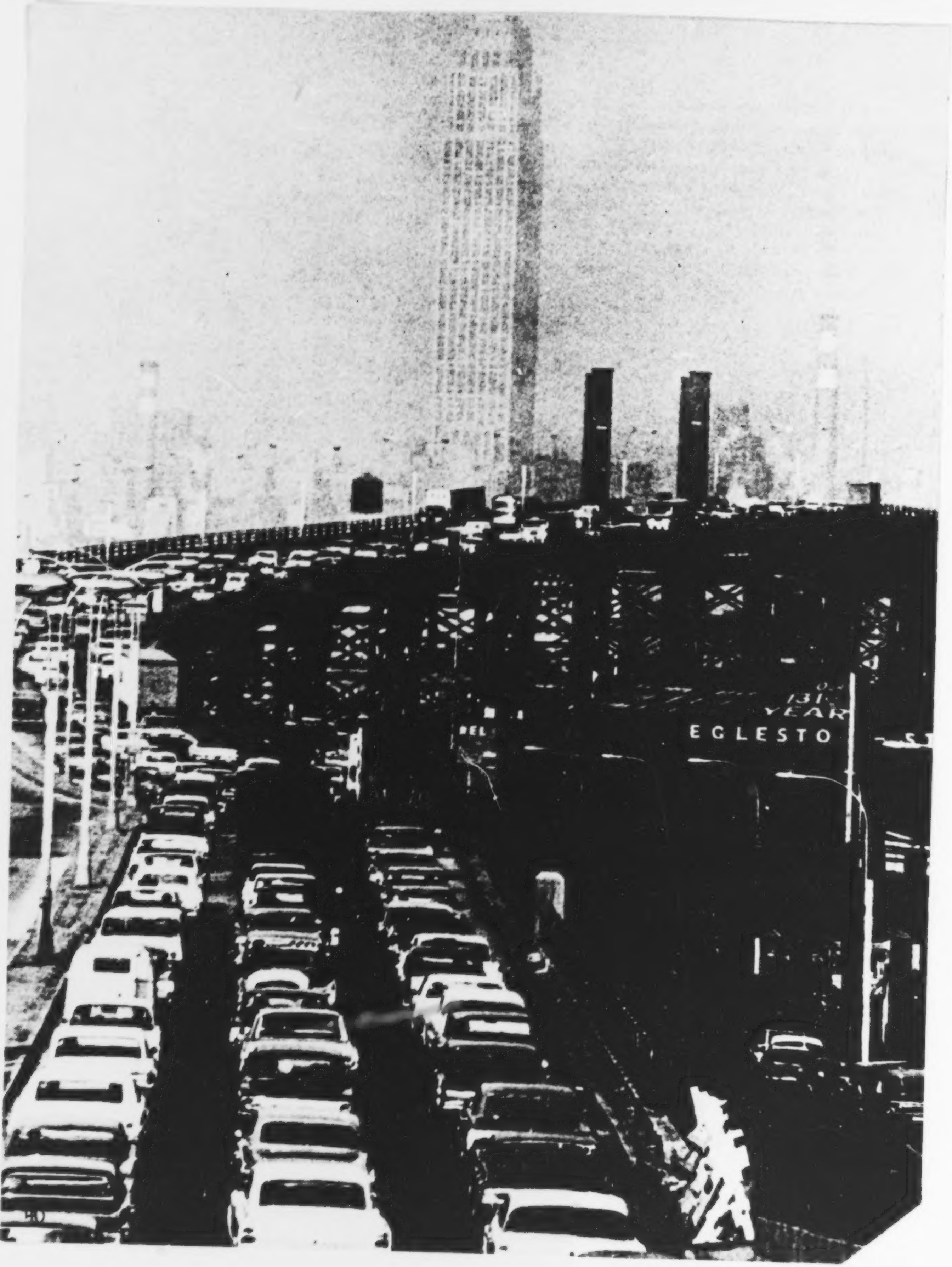
The chairmen of our meetings and sessions should be able to stand up and say with pride, "Ladies and gentlemen, I am pleased to announce that during the session we will be able to breathe clean air. By popular request, the participants have agreed to refrain from smoking during the session."

DAVID L. GALLAGHER (*Worthington Corporation, Harrison, New Jersey*): Vice President Humphrey's statement that "we need nondiffusion treaties between States that share the same airshed" is eminently correct. Under the Clean Air Act the Secretary of Health, Education, and Welfare is given the responsibility of encouraging interstate compacts. Yet there seems little tangible evidence of such encouragement. In particular, the Secretary does not seem to have urged Congress to approve the Indiana-Illinois compact.

WILLARD P. BERGGREN (*Dean of Engineering, University of Bridgeport*): I should not have considered it necessary to ask for the floor had I realized that the question of the rights of the nonsmoker would already have been raised. I would not dwell on his rights, nor even on his health, because I would interpret Dr. Chapman's remarks to suggest that we can't very well, as nonsmokers, even as much as smokers, point to any health deterioration from tobacco smoke. But I think I can point to a couple of objective things and perhaps say something a little constructive about what to do.

I think even though the nonsmoker cannot claim that his health has been impaired by the smoke of his neighbor, he can certainly testify, and I suppose can prove, that his discomfort and even his anger have decreased his effectiveness. Therefore, I think you might find that the nonsmokers are less effective in conferences and that a lot of them might not even come unless required to.

Here is something which I hope will be constructive: In conferences of any size from 12 persons up, it would not be difficult to reserve a certain side or a certain section of the room for those who want the air they breathe to come from unmixed air sources.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December 13, 1966

PANEL A
MOTOR VEHICLES

FIRST SESSION

Chairman Eric P. Grant
Executive Officer, California
Motor Vehicle Pollution Control Board
Los Angeles, California

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". . . engineer, administrator, attorney . . . veteran of a dozen years in the California air pollution wars through service in the Los Angeles County Control District and the State Pollution Control Board . . ."

STATUS REPORT

ERIC P. GRANT
Executive Officer, California Motor Vehicle Pollution Control Board
Los Angeles, California

On behalf of the sponsors of the National Conference on Air Pollution, it is a pleasure to welcome you to Panel A, dealing with motor vehicles.

During the course of this session and the one this afternoon, you will become acquainted with the opinions and conclusions of acknowledged experts on all facets of the existing national problem that stems from the emission by motor vehicles of pollutants into our atmosphere. All of us here at the Conference are charged with the exciting yet grave responsibility of reducing certain areas of that problem and eventually ridding ourselves and our nation of this dangerous threat forever.

We will learn about past, present, and future vehicular emission controls. We will consider the problems inherent in current programs, and the programs that must be implemented in the future to meet the challenge successfully. We will examine improvements to come in internal combustion engine design, developments in the field of mass transportation, research in new methods of motor vehicle propulsion, and the assessment of programs and projects from a legislative viewpoint.

Increasingly during the last six years, the motor vehicle has come to be recognized as a major source of atmospheric pollutants, harmful in a variety of diverse ways to our health, economy, and environment.

There can be no question in the minds of any of us that the impact of their presence and the dangers these pollutants pose in certain parts of our country are subjects of sometimes smouldering, and ofttimes bitter, controversy. However there can be little divergence of opinion about this obvious fact of life: Emissions from motor vehicles are significant factors in any consideration of the national air pollution problem.

Our studies verify that an uncontrolled vehicle extravagantly wastes one gallon of every ten in the gas tank; that is, 10 percent of the fuel purchased by the motorist is lost to the atmosphere. Thus, in California, for instance, 2 million gallons are wasted every day, and nationwide, 7 billion gallons of gasoline each year are lost. These are disquieting figures.

California, through the pioneering work of the Motor Vehicle Pollution Control Board, has made significant gains in controlling automotive pollutants. We have crankcase control devices on 6½ million vehicles. We have exhaust control devices on more than a million of the 1966 and the new 1967 vehicles. These relatively effective systems are the fruits of research, effort, and cooperation on the part of the State of California and automobile manufacturers.

Because results count most, we are always proud to lay them on the line for all to see and appreciate. California controls prevent nearly half a million gallons of raw gasoline from escaping into the air every day.

We are proud that the Federal Government has taken note of the experience and the efficiency of California's program. The United States has adopted California procedures, rules, and regulations for the establishment of nationwide vehicle emission controls, commencing with 1968 model vehicles.

Yet amazingly, voices still speak out against the need for controls; hands are thrown up in abhorrence at the "cost" of the new Federal programs; and heads shake at the "utter nonsense" of it all.

The Thanksgiving day (1966) smog attack on the Eastern seaboard should give our critics something to think about. The worldwide emphasis given to these distressing events in all media of communication is bound to vindicate the reasoning of those of us who have spoken out in support of air pollution control measures to protect all Americans, and by extension, all mankind.

Today's sessions and the introductory statements directed to the Conference yesterday document the position that the protection of air as a natural resource is of unassailable importance and may constitute the difference betwen life and death for the peoples of the world.

Faced with this catastrophic possibility, the work we must yet do takes on the aura of a crusade. In the light of its enormity, the dollars-and-cents economics involved is, in all honesty, an insignificant consideration.

This is not to say, however, that we should proceed without due deliberation about expense. I think that you will all agree with me when I say that we are duty-bound to make every dollar work to produce the results we desire.

In the West, we feel—and I am sure this is true of the Nation—that the California program and the program soon to be implemented in all our States, and eventually, we hope, in all civilized lands—has been one that bears the unmistakable stamp of cooperative decision-making.

Our need for adequate controls, and automotive engineering groups who have recognized our need, have brought Californians a better-performing automobile with a resultant lessening in air pollutants. Advanced engineering design involving simplification of systems and pertinent modifications is the order of the day in Detroit and in foreign car manufacturing facilities. And we can assume that a leap-frogging effect will arise from these activities to assure us that in the near future the internal combustion engine will no longer be pointed out as a source of pollution to the air we breathe.

Garbage-in-the-air and the motor car will cease to be synonymous. The savings to the American motorist in fuel costs is, and will be, of staggering proportions.

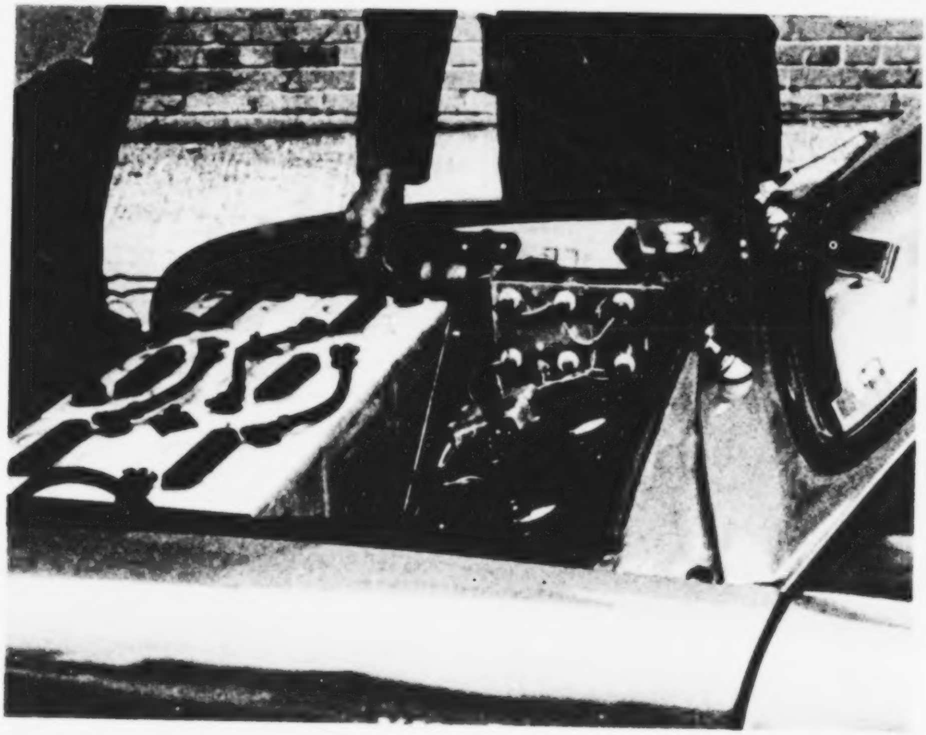
We calculate that this year in the United States there will be 36 million vehicles with crankcase control devices. Since the gasoline that would ordinarily be wasted by blowby emission is recycled through the device, back into the engine as combustible gases, we estimate that American motorists will save themselves about $220 million this year in their auto fuel bills.

Exhaust emission controls will be mandatory nationwide, starting with the '68 model vehicles. Crankcase controls will be installed on 73 million cars, while exhaust emission control by engine modification principally will be included in 25 million vehicles in 1970.

In relation to the nonequipped vehicle of the 1950's, the 1970 model vehicle will be a vastly different automobile. We have come a long way. However, we still have more to do. Even though those vehicles to be produced in 1970 will have 100 percent control of crankcase and evaporation emissions, and will meet the 180 ppm standard for hydrocarbon emissions from the exhaust, we know there is still a long way to go.

I feel confident that when the 1970 model automobiles begin operating on our highways, the internal combustion engine will be redesigned and improved to such an extent that harmful emissions will be almost nonexistent. I feel that the internal combustion engine can be one of the most efficient power packages ever devised.

What will all this mean to the American motorist? It will mean that the American motoring public will save upwards of *two-thirds of a billion dollars* in fuel costs each



year! And as automobiles proliferate this savings will increase.

In addition to operating savings, America's motorists will benefit from significant reductions that will be instituted by manufacturers in the initial cost of the control system. I predict the cost will be less than $25 per vehicle.

Air pollution robs the American people of almost $11 billion each year. It goes without saying that to significantly reduce that total by eliminating the automotive source of pollutants is an accomplishment of which all of us in the motor vehicle pollution control field may be proud.

I am convinced that all of us recognize the urgency of effectively controlling vehicle emissions. Some Americans may disagree as to the methods of achieving this condition, some may disagree as to the immediacy of the need, and some, basing their arguments on program costs and other economic factors, will quarrel with the end results. However, no one of sound mind and practical conscience may take issue with the recognized conclusion that emissions from motor vehicles are major contributors to the filth that befouls the air we breathe.

The papers presented here today emphasize the need for an acute and a continued awareness of the monumental problem of air pollution that has America in its grip. Today's presentations encompass the efforts of the automobile industry to produce engines that don't pollute our air.

You will hear of the real concern of the Congress on this account for the health and welfare of all of our citizens.

You will be informed of the Administration's resolution to protect our atmosphere, and you will certainly be intrigued by the expert observations and research-oriented projections of future controls, and the manner and means of their realization.

At the conclusion of this session, I feel confident we will all possess a greater sense of dedication; we will carry away with us a mounting measure of concern, and most certainly we will benefit from a treasury of knowledge about the problem and what is being done to effect meaningful solutions.

Harmful emissions from motor vehicles *must* be controlled. In the not too distant future, all of us will be able to remark with a sigh and with a great sense of satisfaction, "Remember when?"

". . . research scientist in plant pathology and air pollution . . . longtime director of the University of California's research in this field . . . consultant to many governments . . . now director of PHS programs in air pollution control . . ."

FUTURE AIR QUALITY STANDARDS AND MOTOR VEHICLE EMISSION RESTRICTIONS

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AIR RESOURCE

Air, a mixture of gases and liquid and solid particles, forming a thin envelope around the earth, is a natural resource vital to man, essential for animals and plants, and necessary for man's community, domestic, industrial, and agricultural activities. Both the physical properties of air, such as temperature, density, and movement, and its chemical composition, particularly its oxygen, carbon dioxide, and water, determine the growth and development of plant and animal life and thus are significant parameters of man's use of his land and oblige him to adapt to his environment.

The quantity of air further defines the value of the environment. The body of air with the greatest effect upon man is that of the troposphere, which extends above the earth's surface only seven miles and contains 80 percent of the total atmospheric mass. The air directly available to man is in fact much less. Its availability is dependent upon geographical and meteorological factors not as yet subject to man's control, which define the airshed and determine the rate of diffusion in mixing and thus the concentration of air pollutants. These factors, including the frequent presence and persistence of a confining inversion layer, influence airflow and air mixing and the vertical dispersion of air contaminants.

AIR QUALITY

The quality of air is determined by the uses man makes of it and by the pollutants injected into it. While some degradation is caused by contamination of air by pesticides and chemical manufacture, by far the greatest degradation is brought about by the use of air to support combustion. The amount and kind of pollution vary with the fuels used, but typically the greatest emissions come from the burning of coal with decreasing amounts of pollution from the burning of fuel oil, gasoline, and natural gas. The combustion of a pound of coal requires about 14 pounds of air, with the production of about 2,700 K cal of energy, while the combustion of gasoline requires about the same amount of air, but produces about 5,300 K cal. It has been estimated that fossil fuel used throughout the Nation during one year requires 3,000 cubic miles of air, equivalent to somewhat more than a one-mile-wide air corridor extending from San Francisco to Boston, of which the gasoline-powered motor vehicle uses 640 cubic miles or about 21 percent of the total.

MOTOR VEHICLE POLLUTION

Despite the relative cleanliness of gasoline compared with coal, emissions from gasoline-powered motor vehicles account for a formidable amount of noxious and toxic air pollutants. The array of pollutant chemical compounds emitted by motor vehicles is extensive and includes carbon dioxide, carbon monoxide, gasoline, hydrocarbons, oxygenated hydrocarbons, nitrogen oxides, nitrogen-containing organics, sulfur oxides, aldehydes and acids, phenols, polynuclear hydrocarbons, particulate matter, and lead salts. These materials are air pollutants as emitted to the atmosphere or participate in atmospheric photochemical reactions which lead to the production of other pollutants, such as nitrogen dioxide, ozone, and the peroxyacyl nitrates. Virtually all of the carbon monoxide, nitrogen oxides, and lead salts, and about 60 percent of the hydrocarbons emitted by the motor vehicle come from the engine exhaust; about 30 percent of the hydrocarbon emissions arise from the crankcase; and about 10 percent from the fuel tank and carburetor.

The contamination of the atmosphere by pollutants from motor vehicles, alone and in conjunction with those from other emission sources, creates adverse effects upon the public health and welfare; it affects man's health, irritates the senses, damages property, and interferes with visibility. It is, therefore, important that air of good quality be conserved and maintained, and this can be accomplished only by the proper management of the limited air resource. Unless air of satisfactory quality can be achieved by natural cleansing and atmospheric reaction, it is necessary either to limit or to eliminate emission sources. The restrictions on source emissions must be related to air standards which describe the quality of acceptable air.

AIR QUALITY STANDARDS AND MOTOR VEHICLE POLLUTION CONTROL

Ambient air standards are usually promulgated by State and local governments and are based on valid data which relate air quality to adverse effects upon the health of groups of persons most sensitive to air pollution, as well as upon damaging effects to property and the environment which are judged to constitute a significant economic or social burden.

Ambient air standards adopted since 1959 in California have been developed to show the relationship between intensity, composition, and duration of air pollution and the effects of this pollution upon public health, damage to property, and interference with visibility. These standards include carbon monoxide, ethylene, nitrogen dioxide, the photochemical oxidant complex, and sulfur dioxide, all of which are emitted by the motor vehicle (Table I). Air quality standards for a variety of materials have also been established for several States, including Colorado, Florida, Oregon, Pennsylvania, and New York, and some foreign countries.

TABLE I.—*California ambient air quality standards for first effect or functional alteration level*

Pollutant	Concentration (ppm)	Duration (hours)
Carbon monoxide	30.0	8
	120.0	1
Ethylene	0.1	8
	0.5	1
Nitrogen dioxide	0.25	1
Photochemical complex	0.15	1
Sulfur dioxide	0.3	a
	1.0	1

Recognition of the importance of the motor vehicle as a significant contributor to carbon monoxide and photochemical pollution established the need to restrict vehicular emissions in keeping with the ambient air quality standards.

Exhaust emission restrictions of 1.5 percent carbon monoxide and 275 ppm hydrocarbon were established in 1959 as a first step in reducing carbon monoxide by 60 percent and hydrocarbons by 80 percent in order to meet the ambient air quality standards. Emission determinations are based on specified driving cycle. As a further step in controlling hydrocarbon participation in photochemical pollution, emission restrictions of 0.15 percent by weight of the supplied fuel from the crankcase were involved. Further reductions in permissible emissions of carbon monoxide from 1.5 percent to 1.0 percent and hydrocarbon from 275 to 180 ppm have been adopted and will become effective in 1970. In a further effort to fit emissions of a growing vehicular population to the established ambient air quality standards, an emission restriction of 350 ppm nitrogen oxides from exhaust was adopted in 1965, together with hydrocarbon limitations of 6 g per 24-hour period from fuel tanks, and 2 g per 24-hour period from carburetors, as well as standards for odors and smoke. These latter standards will be of importance in controlling emissions from diesel-powered vehicles.

Mounting dangers to the public health and welfare, damage and deterioration of property, and hazards to transport systems from air pollution resulting from rapidly expanding metropolitan and urban growth, industrial development, and increased use of motor vehicles throughout the country, are amply documented by pollution measurements reported by State and local agencies, and the National Air Sampling Network and Continuous Air Monitoring Program conducted by the U.S. Public Health Service. The areas affected include all of the metropolitan and urban centers and many other communities, and thus air pollution now affects a majority of the Nation's population.

Congressional concern with the problem led to the enactment of the Motor Vehicle Air Pollution Control Act in 1965. This Act directed the Secretary of Health, Education, and Welfare to establish emission standards for all new motor vehicles. A regulation prescribing national standards was issued, stipulating permissible emissions. Complete control of crankcase emissions is required. Carbon monoxide and hydrocarbons from exhaust are restricted by engine displacement classes in such a way as to provide for a reduction of these pollutants on a semiqualitative rather than on a concentration basis (Table II).

TABLE II.—*National motor vehicle exhaust emission standards*

Engine displacement (cubic inches)	Pollutant	
	Carbon monoxide (percent)	Hydrocarbons (ppm)
Above 140	1.5	275
101 to 140	2.0	350
50 to 100	2.3	410
Below 50	None	None

A fundamental responsibility of the Federal Government is to protect the Nation's air resource by providing leadership and financial assistance to State and local governments so that they may best discharge their responsibility for prevention and control of air pollution at its source. The mobility of motor vehicles and their interstate movement and the common occurrence of motor-vehicle-created pollution throughout the Nation are all factors in the preferences for national, rather than State or local standards for emission control. California has recognized, by its recent adoption of the new Federal standards, the desirability of a national policy for motor vehicle emission control.

MOTOR VEHICLE POLLUTION CONTROL

Control of motor vehicle emissions in accordance with standards established in California was achieved by an action program of the California Motor Vehicle Pollution Control Board. Approval of control devices and systems was based on compliance with criteria determined by specified test procedures, and laboratory, proving-ground, and road-performance evaluation. All new cars in California since 1961 have had crankcase controls, and since 1965 have had exhaust controls. Crankcase controls have been required on all 1955 and subsequent-year used cars by installation of devices at the time of car resale. Surveillance studies have shown crankcase control systems to be effective and operating within standards, except for those installations which are neither serviced nor maintained.

Surveillance studies of exhaust controls showed that both engine modification and air injection systems complied with emission standards on the average but with varying ranges of compliance. The engine-modification systems, which are subject to service requirements, showed a wider range of emissions than did the air-injection systems. Both systems under individual ownership and operation gave higher emissions than the same systems under fleet ownership or proving-ground testing. Test procedures for device approval may need to be improved or mandatory inspection for compliance may become necessary if future motor vehicles show the same performance variability in order to insure continued acceptable emission reduction throughout the vehicle's life.

NEED FOR FEDERAL AIR QUALITY STANDARDS

Increases in population and extension of urbanization throughout the country cause concomitant increases in air pollution. Any community of 50,000 or more residents is large enough to have a potential of motor-vehicle-created air pollution. As the size of a city increases, the amount of air pollution not only increases, but the area plagued by pollution does also. Doubling a city's size can increase the area subjected to pollution as much as ten times. The amount of pollution and the area affected by it are determined by the number and kind of sources, their geographic location, and weather conditions which govern the flow of polluted air from one city to another, and from city to farm and to recreational and wildlife areas. The regional manifestations of air pollution are well documented. In California alone, more than 11,000 square miles are affected; many more than that are affected from Massachusetts to Florida.

Because of the rapidly expanding population growth and industrialization, the potential for air pollution episodes as determined by geographic and meteorological factors becomes increasingly important and must be reflected in future governmental decisions for air pollution control. Recent studies by the Meteorology Section of the National Center for Air Pollution Control have shown such potential to exist over wide areas of the United States. Only four central States had no days specified as "high-air-pollution-potential" days. High-pollution-potential days were forecast for eight days of the year in six western States, while portions of five States were affected 16 days. Inland central California was concerned 20 days of the year. The 33 remaining States, while affected about half as often by "high air pollution potential," contain the principal industrial and metropolitan centers of the Nation as well as the preponderance of the motor vehicle population. Five States are involved nine days a year, while most, if not all, of 28 States are affected five days; only five States were identified as having fewer than three days a year.

The large number of States subject to air pollution episodes, their grouping into areas of social and industrial patterns, the regional aspect of many of the airsheds, and their frequent multistate involvement and similarity of environment, all suggest the need for setting national air quality standards for the protection of public health, property, and the quality of the air resource. Uniformity of standards is also desirable because of population mobility and the regular use of motor vehicles for interstate transportation of people and goods. Use of national standards provides the manufacturers of motor vehicles and other pollution-generating equipment a basis for design compliance acceptable to markets throughout the Nation. Establishment of single standards for national application provides for the relief from pollution in critical areas and at the same time provides pollution prevention in currently less critical areas. Uniformity in standards is an important factor in helping State and local governments establish the relative importance of stationary sources of pollution and to control the emissions from those, so that the requisite balance in control between stationary and mobile sources can be attained and the quality of air throughout the affected airshed may be properly conserved.

FUTURE FEDERAL STANDARDS

The Federal Government has established motor vehicle emission standards designed to restrict the amount of carbon monoxide, which directly affects human health, and hydrocarbons, which may participate in the photochemical air pollution process, the products of which variously affect health and well-being. It is presumed that these restrictions are related to ambient air quality standards as developed in California, which were destined to protect man, his property, and his environment, from damaging pollution. That air pollution is an aggravating problem in the principal cities of the Nation should be common knowledge. The relative importance of pollutants varies, depending on fuels used and the economy of areas affected. To illustrate the problem, maximum concentrations of selected pollutants measured for one year, largely during 1964, are given in Table III.

These one-hour-averaged data show carbon monoxide to be present in all cities but all below the California ambient air quality standard of 120 ppm. The presence of photochemical air pollution in all cities is clearly shown by elevated levels of hydrocarbons and nitrogen oxides; oxidant measurements attest to the photochemical reactivity of the hydrocarbons. Oxidant levels exceeded the California standard of 0.15 ppm in five cities and approached it in two. Sulfur dioxide exceeded the standard of 1.0 ppm in Chicago and New York and was notably low in Los Angeles, New Orleans, and San Francisco.

RELATIONSHIP BETWEEN STATIONARY AND MOTOR VEHICLE SOURCES

The common occurrence of carbon monoxide and hydrocarbons indicts the motor vehicle as a significant pollution source. The relatively higher concentrations of sulfur dioxide in the Midwest and East compared with the West shows the importance of combustion of fuel from stationary sources as a factor in air pollution. The generally high levels of nitrogen oxides support the thesis that combustion from both mobile and stationary sources has an effect upon air quality directly as well as by participation in the formation of photochemical air pollution and the production of oxidants.

Population growth, urban development, the nature of cities, and their energy requirements and transportation systems, all contribute to the general pollution of the air resource as it moves about the airshed. The conservation of air quality demands that the influence and interaction of pollutants from both stationary and mobile sources be controlled and that the degree of control be related to established air quality standards.

THE NEED FOR TIGHTER EMISSION CONTROLS

Metropolitan-area growth and the way in which urban areas have evolved have in large part been due to the use of the motor vehicle as the basic form of transportation. In spite of the "population explosion," the

TABLE III.—*Maximum concentration (ppm) of selected pollutants for 1 hour averaging time*

City	Carbon monoxide	Hydrocarbons	Nitrogen oxides	Oxidant	Sulfur dioxide
Chicago	46	8	1.05	0.13	1.12
Los Angeles	43	....	1.39	.49	.19
New Orleans	....	....	.43	.17	.10
New York	27	13	.65	.12	2.20
Philadelphia	37	12	1.27	.20	.84
San Francisco	43	12	.76	.17	.16
Washington	41	15	1.41	.18	.62

number of motor vehicles in use is increasing at an even faster rate than that of people. In 1959, for example, 72 percent of Los Angeles families owned an automobile; in 1963, 85 percent did. The increase in the number of motor vehicles is also shown by the ratio of population to the number of registered vehicles. In 1960 there were about 2.5 people per car in California; in 1965 there were only 2.0 people per car, and it is expected that there will be 1.7 in 1970, and possibly 1.5 in 1980.

The increased number of motor vehicles increases pollution directly; further, more vehicles and greater congestion of already congested roadways will cause increased air pollution because of reduced average vehicle speed occasioned by "stop-and-go" driving. Both the speed and the flow of traffic affect the amount of pollution. Vehicular pollution is created at a rate approximately inversely proportional to speed; an increase in speed from 20 to 30 mph yields about a one-third reduction in pollutants, while a change from 20 to 40 mph brings about a twofold reduction. Street and highway systems which improve traffic flow and increase average speed of travel must be developed. Public transport systems which will conveniently reduce the need to use individually-owned vehicles for daily work transportation are also mandatory. Failure to progress in these areas will inevitably bring about restrictions on the use of motor vehicles in metropolitan areas and force drastic reductions in permissible vehicular emissions or changes in vehicular powerplants.

FUTURE STANDARDS

Control of the air environment requires the establishment of source emission standards designed to insure clean air as defined by valid and adequate air quality criteria and ambient air standards. Air quality standards must be established for all source emissions for airshed application with special consideration of the downwind user and his economic and social needs. Adoption of source emission standards depends upon the development of national air quality criteria and recommended standards.

IMPROVED CARBON MONOXIDE AND HYDROCARBON STANDARDS

The importance of the motor vehicle as a serious national pollution source has been recognized and a national control program is scheduled to begin in late 1967 with the introduction of the 1968 models. These vehicles will be equipped to completely control crankcase emissions and to control exhaust emissions for carbon monoxide and hydrocarbons to a specified level (see Table II). Since the vehicles produced in 1967 will pollute the air throughout their ten-year life, emission controls must relate to air quality requirements and motor vehicle populations in 1977. The adopted Federal standards are similar to those of California, which were designed to reduce metropolitan pollution in 1970 to the same levels of pollution that existed in 1940. No more than one-half of California vehicles will be in compliance by 1970 because of delayed installation of controls, and therefore the desired ambient air quality sought cannot be achieved.

The adopted California 1970 restrictive emission standards have not been adjusted to compensate for the 5-year lag in compliance and they, therefore, cannot meet the established goals for 1980. The added pollution effect of more vehicles, more congestion with higher concentration of pollutants, and increased effluent from impeded movement, requires that more restrictive standards be adopted to meet not only California's needs but also those of the large number of States with extensive metropolitan areas, urban centers, and heavy concentrations of motor vehicles.

More stringent emission standards for carbon monoxide and hydrocarbons are necessary to merely cope with control of California's motor-vehicle-created air pollution; identical standards may be expected to do little more than that with vehicular pollution in New York, New Jersey, Pennsylvania, Ohio, Maryland, Virginia, and the District of Columbia. The application of the same more stringent standards to other States may be expected to provide the hoped-for control job—namely, the prevention of motor-vehicle-created pollution.

A serious shortcoming in the setting of emission standards is their limitation to new motor vehicles, which, even after initiation of a control program, represent only one-tenth of the moving average annual population.

Immediate control of emissions from all used vehicles would bring about a dramatic improvement in air quality. Such a control program is presently not feasible from a technical, economic, and public acceptance viewpoint. The ten-year delay in achieving cleaner air by ignoring used vehicles and limiting control to new ones could be offset by adopting emission controls which in effect achieve the expected ten-year goal in no more than five years and at the same time offset increases in vehicular emissions due to more vehicles, reduced average speeds, and congestion. The control standard for carbon monoxide would be expected to be less than 1.0 percent, while that for hydrocarbons would be less than 100 ppm for engines larger than 140 cubic inches, respectively; further restrictions may be imposed to meet national ambient air quality requirements.

In addition to control of hydrocarbons from exhaust, those from fuel tanks and carburetors must be restricted. These evaporative losses represent 10 to 15 percent of the hydrocarbons emitted from gasoline-powered vehicles. The sources are amenable to complete control and standards should be set on that basis.

HYDROCARBON REACTIVITY

Hydrocarbons are controlled for the purpose of reducing them and their oxygenates, which themselves cause adverse effects and to reduce the photochemically-produced air pollution products which adversely affect the health of man and damage his property. The amount and kind of products formed vary with the reactivity of the hydrocarbons because of their composition and structure. Control of polluting effects can, therefore, be most effectively achieved by establishing emission standards based on hydrocarbon reactivity. Relative reactivity of olefins, aromatics, and paraffins is most meaningful when it is related to products causing harmful biological effects, although consideration must be given to reactivity as related to ozone, peroxyacyl nitrate, and nitrogen dioxide formation, as well as to hydrocarbon disappearance. Modification of existing hydrocarbon standards to meet reactivity requirements will occur as test procedures and measurement techniques are prescribed.

In addition to the improvement of established standards for carbon monoxide and hydrocarbons, standards should be considered for other vehicular pollutants such as oxygenated hydrocarbons, oxides of nitrogen and sulfur, fuel additives including lead, smoke, and odor.

NITROGEN OXIDES

Whereas a reduction in carbon monoxide has a direct beneficial effect, and the reduction of hydrocarbons reduces the effects of the photochemically-formed products, the benefits from a reduction of the oxides of nitrogen are dependent upon the effectiveness of hydrocarbon controls.

Unlike emissions of carbon monoxide and hydrocarbons, which increase under conditions of poor combustion, the nitrogen oxides characteristic of the combustion process increase as combustion efficiency improves. The principal nitrogen oxide formed is nitric oxide, which, during the initial exhaust-dilution stage, in a dark reaction with oxygen, forms nitrogen dioxide. The rate of conversion is rapid in air mixtures of 10 to 70 percent exhaust, very slow in mixtures containing less than 1 percent exhaust, and negligible in the ppm range. Atmospheric light reactions account for still more rapid rates of conversion of nitrogen dioxide. The light reaction leading to the formation of nitrogen dioxide, however, would be slowed by control of hydrocarbons, and there would be less nitrogen dioxide incorporated into photochemical air pollution products. Complete control of hydrocarbons would result in a mixture in which the nitrogen dioxide to nitric oxide atmospheric ratio would remain unchanged even in daylight. However, with only partial hydrocarbon control the observed daytime effect would be a steadily increasing concentrating of nitrogen dioxide, thus increasing the time-concentration exposure.

While the benefits of further reductions in photochemical air pollution products through control of nitrogen oxides may be controversial, there is no doubt that they should be controlled because of their direct toxicity, and adverse effect upon air quality. The multiplicity of sources, and the relative significance of the emissions of nitrogen oxides from thermal powerplants, industrial processes, space heaters, and motor vehicles, favor the adoption of an ambient air standard for nitrogen dioxide and relating restrictions of vehicular nitrogen oxides to the total oxides of nitrogen emitted within the airshed.

SULFUR OXIDES

Control of sulfur oxides from motor vehicles has not received much attention because of the relatively small percent of these oxides emitted by these vehicles compared to stationary sources. The quantity discharged may be comparatively small so far as the sulfur burden of the air is concerned, but the sulfur present in the exhaust effluent plays an important part in the formation of photochemical particles. Their size distribution favors widespread atmospheric distribution and ready inhalation. The chemical characteristics of the particles are poorly known but even if they are "inert" their size is such as to enhance the toxic pulmonary effect of sulfur dioxide. Some consideration should be given to the need for an emission standard for sulfur-generated exhaust particulates.

FUEL ADDITIVES

A variety of supplementary chemical compounds are typically added to lubricating oils and fuels to improve vehicle performance engine operation. Materials added to fuels are of prime concern since they are readily discharged into the air. Compounds most commonly used contain barium, boron, lead, and nickel.

Information on the quantity of these materials released to the air by motor vehicles is meager and inadequate. Interest in the nature of the lead hazard to the general public has provoked some study and considerable discussion of atmospheric lead levels as reported by the National Air Sampling Network and the three urban communities of Cincinnati, Los Angeles, and Philadelphia. The average concentration of lead in all samples obtained in each city ranged from 1.4 micrograms per cubic meter in Cincinnati to 2.4 in Los Angeles, while the mean concentration of lead in heavy traffic was ten times higher: 14μg/M^3 in Cincinnati and 25 in Los Angeles. The relatively lower levels of lead in rural than in urban air were reflected in an increased concentration of lead in the blood of groups of persons as they varied from rural to downtown living and work areas.

Atmospheric lead has also contributed to unusual burdens in plants growing near major highways and lesser roadways. Pasture grasses range from 3000 to 700 ppm; vegetables from some city gardens located near streets have shown as much as 115 ppm lead. Public exposure to lead and its uptake by the body results from eating, drinking, smoking, and breathing. The importance of lead additives to the environment not merely to air, but to foodstuffs, water and land, from use of leaded fuels in motor vehicles, must be determined and critically evaluated so that appropriate action on vehicular lead emissions can be taken.

The present concern for lead appears to have overshadowed the possible adverse health effects of barium and nickel. The acknowledged toxicity of certain barium compounds and the recognized toxicity of nickel suggest that the exact chemical nature of the vehicular emissions involving barium and nickel additives be determined and that consideration be given to the establishment of appropriate standards.

OTHER ORGANIC COMPOUNDS

Several oxygenated hydrocarbons have been identified as vehicular emission products as well as products of ambient air photolysis of vehicular emissions. The aldehydes, especially formaldehyde and acrolein, are known to be toxic and irritating, and at times to be odoriferous. Incomplete information on aldehydes and other organic compounds associated with gasoline and diesel exhaust does not permit standard development at this time.

ODOR

The odor from diesel-powered vehicles is typically unpleasant, obnoxious, and irritating. While the area of influence may be restricted, the local nuisance created and its general repugnancy are intolerable and must be controlled. Standards should be established on an odor basis as detected and evaluated by a select panel, giving consideration to subjective objectionability and irritation. Procedures, methods, and evaluation techniques developed for diesel systems should be adaptable to gasoline or other fuel-powered vehicles and amenable for use in urban and rural zones.

SMOKE

Smoke standards are needed to restrict emissions from diesel-powered vehicles as well as from improperly operated and maintained gasoline-powered ones. Smoke is objectionable not only because of its discoloring and obscuring effects, but also because it contributes particles which soil property and have the potential for enhancing pulmonary distress either directly or in combination with gaseous air pollutants. Standards may be established initially by visual observation by specification of a Ringelmann number, but since the quantity of particles and their size distribution are important, consideration should be given to standards based on objective measurements of density.

The present standards and suggestions for their improvement, together with possible new standards, have emphasized the gasoline-fueled passenger car and some trucks and buses. In addition to more acceptable and comprehensive standards for these 1970-model vehicles, standards are required for all trucks and buses, both gasoline and diesel-powered. The establishment of standards based on single pollutant effects, while representing a necessary step towards improvement of air quality, implicitly neglects the implications of effects associated with recognized combinations of gaseous and particulate pollutants; future emission restrictions must consider pollutant interaction and effect enhancement.

The promulgation of emission standards upon mass emission rather than concentration, and vehicle weight as well as engine displacement, should be considered.

Improvements in the effectiveness of standards may be expected to result from improved sampling and analytical methods, as well as from better designed and operated test dynamometers, test cycles, road tests, and especially from performance testing under consumer controlled situations.

COMPLIANCE AND SURVEILLANCE

The success of abatement of motor-vehicle-created air pollution depends not only upon the setting of national standards designed to control the various pollutants in the most seriously affected model communities and metropolitan areas, but also upon continued compliance of approved vehicles with those standards. Performance of approved control systems or engines while based on a 100,000-mile lifetime, nonetheless needs "in-normal-use" verification through surveillance inspection and testing, and provision for service and maintenance. The degree to which control is effected therefore is dependent upon the adequacy of surveillance programs.

CONCLUSION

The development of future motor vehicle emission standards must necessarily be related to the effectiveness of existing vehicular controls as determined by such surveillance, and to the effectiveness of controls over other pollution sources within the affected areas.

Future regulations for the control of vehicular emissions must be based on national air quality standards which reflect the health and welfare needs of the general public. Refinement of existing data and development of additional information to resolve current questions as to the roles of various pollutants in the formation of air pollution will permit the setting of new standards and the revision of existing standards to best protect this country's health and welfare.

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DISCUSSION

FUTURE AIR QUALITY STANDARDS

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Dr. Middleton dramatically describes the air pollution problem facing us. In his paper he gave us the specifics of the California air quality standards, and also the national motor vehicle exhaust emission standards, and he has raised some important questions.

On considering the air quality standards that have been established by the State of California, I am, as a physician, concerned about the adequacy of the protection offered when the concentration of carbon monoxide is permitted to be as high as 120 ppm for one hour.

I have been impressed with the evidence, some of it rather recent, which shows that we have health effects at appreciably lower levels. Significant functional alterations in neurosensory responses, as measured by cognitive and perceptual deficits in reactions of healthy young men, have been recorded at levels of around 50 ppm for one hour. These findings are reinforced by evidence from laboratory animal investigations showing that altered neurosensory responses involving visual discrimination and alertness occur under equivalent exposure conditions.

Further support of a more conservative standard comes from evidence that continuous exposures of animals for ten weeks to concentrations as low as 2 ppm causes changes in porphyrin metabolism and morphological changes in isolated nerve cells.

Among the several items that Dr. Middleton is concerned about is the need for setting uniform standards for motor vehicles, applicable to the entire nation. And this item strikes a very sensitive point with me because I have been personally involved in documenting the relationships between specific pollutants and their effects. The National Center for Air Pollution Control has felt a sense of responsibility for organizing the available information so that it will more readily lend itself to objective analysis for use in establishing air quality standards.

Early in the long chain of decisions needed to determine the appropriate values for standards, I believe we need to decide what our air quality goals should be. The point I want to make is certainly not new here, but I think it deserves some emphasis. It seems to me we will be able to improve the objectivity and the uniformity in the needed regulations if we not only promulgate air quality standards and emission regulations, but in addition, it would be wise first to decide what values best meet our needs, purely from a health and welfare standpoint, and promulgate them as goals, preferably national goals. Then, when a decision is later made, based on such practical considerations as cost, time, and availability of control techniques, these previously established goals will exert a stabilizing force that will permit greater uniformity in the standards developed by the many pollution control agencies.

During the course of developing what we call air quality criteria, this question has repeatedly arisen: "How can we best arrive at precise values in view of the incomplete evidence of the relationship between air pollutants and health?"

The best answer to this question that I have been able to find comes from a paper written by Sir Austin Bradford Hill.* Speaking about the relationship of environment and health, he lists eight points which need consideration in the analysis of evidence of an association among many variables: First on his list is the strength of the association. The points which follow are: (2) the consistency of the pattern of the findings in multiple observations; (3) the specificity of the association; (4) consideration of the temporal relationship of the association; (5) the quantitative relationship—the biological gradient or the dose-response relationship; (6) the plausibility of the relationship from a biological standpoint; (7) the coherence of this relationship with generally known facts; (8) the application of judgment by analogy.

I believe a more conservative air quality standard for carbon monoxide is indicated. I feel we stand a better chance of obtaining uniformity of the standards emphasized by Dr. Middleton, if we decide early what is needed for the protection of health and prevention of damage, exclusive of all other considerations. And further, that we apply Bradford Hill's points in our analysis of the evidence.

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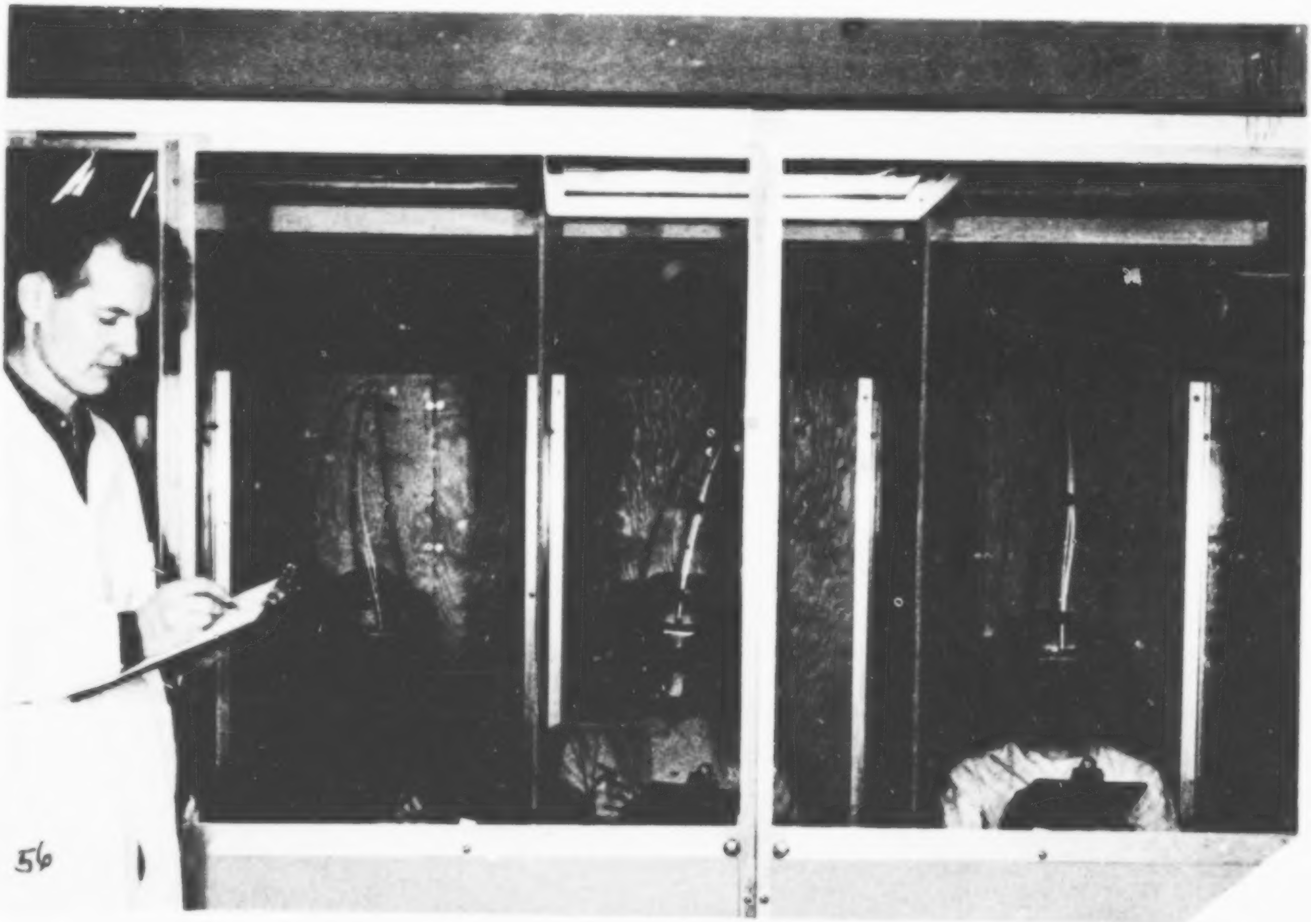

". . . no name more consistently associated with air pollution control . . . director of Los Angeles task force on air pollution . . . for eleven years chief of control for that city . . . past president of APCA . . . now in charge of PHS abatement program . . ."

REGULATION OF NEW MOTOR VEHICLES

In the short time since the national program for motor vehicle air pollution control has been in effect, it has been on the receiving end of more brickbats than praises. I would like to take this opportunity to set the record straight. First of all, automotive air pollution is not a myth. It is not a figment of the imagination, dreamed up by Hollywood's television comedians and fostered by the Los Angeles County Board of Supervisors, with its control baselessly perpetrated by the California State Legislature.

The characteristics of Los Angeles smog are evident today in urban communities across the Nation. As public servants with the responsibility of protecting the Nation's health, we would be remiss to ignore the lesson that Los Angeles is teaching us.

In spite of a 30-percent reduction in the hydrocarbon emissions of the average automobile driven in California, there were four occasions this year when it was necessary to alert the Los Angeles public to the developing danger from ozone. On one occasion the ozone count reached a value of .82. Had it risen to one part of ozone in a million parts of air, it would have been necessary to bring this huge metropolis to a virtual standstill in order to protect the health of the public against further atmospheric contamination.

Obviously, what we are witnessing in Los Angeles is a runaway problem which will not be curbed by current measures. The immensity of the problem, and the hopelessness of solution through state-of-the-art technology has prompted a California official to invite legislation which would ban the sale of conventional automobiles as early as the year 1980.

Control of automotive air pollution on a national basis is essential if similar runaway problems are to be prevented in other metropolitan areas. There is a lesson here also, it seems to me, which the automotive and petroleum industries might well take to heart, out of consideration for the continued prosperity of their industries.

The mandate under which we labor is known as the Motor Vehicle Air Pollution Control Act. It is an amendment to the Clean Air Act of 1963 and was signed by President Johnson as recently as October 20, 1965. It is designed to achive uniform national control by limiting the emissions from all new motor vehicles introduced into commerce, whether manufactured in the United States or imported from abroad.

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It authorizes the Secretary of Health, Education, and Welfare to establish standards for the emission of any substance which, in his judgment, is or may be injurious to public health or welfare, and to require compliance with these standards. At the same time, the Act specifies that appropriate consideration be given to technological feasibility and economic costs in prescribing standards applicable to new motor vehicles or engines.

Just 72 days after the Muskie Bill became law, the Secretary published his proposed regulations in the Federal Register and, following required consultations with domestic and foreign manufacturers, Federal emission standards were formally promulgated on March 30, 1966, These standards are applicable to the 1968 model year and reflect those currently in effect in the State of California.

To implement these standards, to test for compliance, and generally, to provide the necessary machinery for insuring that the public gets the control it needs, the Abatement Branch of the National Center for Air Pollution Control has established a fully-equipped laboratory at the Willow Run Airport near Detroit. This laboratory also has the responsibility for evaluating the adequacy of existing standards and the ultimate need for more severe standards and less complex test procedures.

We are also conducting field surveys of equipped vehicles in California and elsewhere. Initial certification of new systems is approved on the basis of performance of *test* vehicles. But the continued approval for succeeding years will be determined by the effectiveness of the control systems when evaluated under realistic driving conditions.

Control of pollution from motor vehicles by the Federal Government has a far-reaching impact. It relieves State and local governments of a major responsibility, but this will be a mixed blessing if it hampers or delays local control programs where they are needed most.

The automobile industry, however, must assume the lion's share of the responsibility for the "cleanness" of its product, or surely it will suffer the anathema of a justifiable disillusioned public. The Federal standards which go into effect for the 1968 model year reflect, in general, the state of the art in emissions control. However, I would like to point out areas where these standards fall short of the needs and thereby indicate to officials of the automotive and petroleum industries, as well as to the general technical community, fruitful areas for applying their talents.

State-of-the-art exhaust control systems for new automobiles have been in general use in California for just over a year now. Their performance has been somewhat disappointing. Vehicles operated by the public in everyday driving are deteriorating faster than the emission data submited by the industry had led us to expect. Obviously, vehicles in public use are not receiving the same degree of maintenance as units operated on industry proving grounds. In view of this, it appears necessary to fully implement the Federal procedure for annual certification at the expense of the manufacturer to assure that the vehicle and engine continue throughout the first 50,000 miles to conform to the regulations.

Current Federal exhaust emission standards are based on the concentrations of the pollutants emitted. These standards have been adjusted to reward the smaller-displacement engines for their lower volumes of exhaust. But they do not penalize the monsters for their higher exhaust volumes. We propose to make these standards more equitable across the entire range of power train-vehicle configurations by basing them on the weight of contaminants emitted to the atmosphere.

In its motor vehicle control program, the Department of Health, Education, and Welfare has adopted the policy that national standards shall reflect that degree of control over various pollutants required to protect the air quality in the most seriously affected areas. The situation in any one area, therefore, would not necessarily govern the determination of a national standard. For example, hydrocarbons appear to be of most significance in the Los Angeles Basin. It may be found that carbon monoxide is of most concern in the canyons of Manhattan. And nitrogen oxides may be of greatest importance in some other urban area. National standards would reflect compositely, the most critical considerations of all areas. This is in accordance with reasonable and well-established principles of protecting the public health and welfare against the worst conditions encountered.

Current compliance certification of new motor vehicles and engines is based on the average performance of a small sample of each engine-transmission-carburetor category, averaged over the projected life of the unit. Under this procedure, it is reasonable to expect that there will be a number of vehicles coming off the assembly line whose emissions exceed the numerical value of the basic standards. Although the intent of the standard is not violated thereby, this consequence presents complications for a State inspection program aimed at keeping individual, privately owned vehicles within the compliance requirements.

A solution to this problem which imposes no expense and a minimum of inconvenience upon the owner must be sought. The solution might entail requiring that each car leaving the assembly line meet the Federal standards for all contaminants. Current Federal standards require an industry warranty to maintain all vehicles within compliance during the first 50,000 miles of operation.

Were it not for the toxic nitrogen dioxide in the atmosphere, there would be no photochemical smog, which is one of the two major reasons for controlling automotive emissions. Still, there is no current Federal standard requiring its control. As the hydrocarbon and carbon monoxide baseline emissions have gone down, the nitric oxide baseline has gone up. Emission control criteria limiting the content of toxic components in the controlled exhaust have proved to be ineffective in preventing an increase in nitric oxide emissions to the atmosphere.

It becomes necessary, therefore, to establish an oxides-of-nitrogen standard.

There are two arguments offered by opponents of a nitrogen dioxide standard. The first argument is that its implementation will result in an increase in ozone in those areas where the oxides of nitrogen levels are high. Yet, in Los Angeles, where nitric oxide emissions have risen relative to hydrocarbon emissions during the past six years, there has been no abatement in the frequency or intensity of ozone attacks. The second argument is that an effective control that will not penalize engine performance is just not currently available. Real progress is being made, however, in this area, and there is every reason to believe that refinements to existing hardware will meet this objection.

In most communities other than California, the oxides-of-nitrogen levels are much lower. They fall within the range where nitrogen dioxide becomes a contributor equal to, or even greater than, the hydrocarbons in causing photochemical smog. Control of nitric oxide emissions in these urban areas is as important as the control of hydrocarbons in preventing eye irritation, reduced visibility, and vegetation damage, as well as increasing quantities of the highly toxic ozone.

Worldwide, the vehicular pollutant of greatest concern to health officials is carbon monoxide, and increasingly stringent emission standards can be expected for CO. Acute effects of this toxic gas have been known and studied for decades, particularly with respect to industrial hygiene and home safety. Recent evidence indicates that carbon monoxide in community atmospheres is far more serious, and at far lower concentrations than were previously considered significant. Threshold effects on mental processes which have important implications regarding reaction time and driver fatigue have been found at carboxy-hemoglobin levels of 1 to 2 percent. To protect anemic, cardiac, or respiratory-impaired people, it may be necessary to base emission controls on eight-hour air quality levels of five parts per million or less of carbon monoxide versus the 30 ppm presently stipulated in California and the 15 ppm tentative air quality objective adopted in New York State.

Current emission control standards relate to passenger cars and lighter commercial vehicles. Heavier commercial vehicles are responsible for about 15 percent of the total automotive contribution to air pollution and we are now developing procedures whereby these vehicles may be brought under control.

Diesel engines, with their smoke and their odors, assail the senses of all people in all communities, on the highways and in the cities and towns, whether a temperature inversion exists or not. We are making every effort to insure that this problem is brought under control as expeditiously as possible.

Spillage and evaporation losses from the fuel tank and carburetor are the only remaining sources of hydrocarbon emissions from the gasoline-powered motor vehicle which are not under some degree of control. With blowby emissions completely eliminated, evaporation losses account for about 20 percent of the motor vehicle's emissions. Purchasers of the 1970-model-year motor vehicle may expect to find highly efficient evaporation loss controls, conserving gasoline and eliminating air pollution from this source.

Gasoline-powered motor vehicles represent the major source of lead in the atmosphere. Because of the highly toxic nature of this contaminant, measures aimed at its control will have to be developed. These will probably be directed at the fuel composition rather than the vehicle's exhaust.

To State and local officials, who understandably are desirous of more and quicker action at the Federal level, I would like to point out that it's hardly more than a year since the Motor Vehicle Air Pollution Control Act became law. The Federal program outlined here should convince you that we are alert to your needs and that the speed with which this program is being implemented is not only creditable, but also unprecedented. Few programs have gone so far so fast.

To those people who question the need for national control of automotive pollution, the recent smog attack along the East Coast should serve as a reminder that temperature inversion can occur outside of California; and, if we don't heed the warning signs that stand out so clearly now, we might well find before the turn of the century that pollution in several metropolitan areas will have exceeded a point at which only the healthiest may long survive. There still is virtue in prevention and I for one, along with many others, strongly oppose any attitude that control is not needed until the problem exists.

I would hope that the automobile industry, having accepted its responsibilities in California, will keep faith with the people of this Nation who rely so heavily upon its products. The industry, important as it is to the economy of the Nation, cannot be permitted to impair the health of the people. We may rely upon the motor vehicle manufacturers to lead us back to praise of these wonderful instruments of their craft, instead of their condemnation.

In conclusion, I would like to point out that, for the long pull, any goal short of complete elimination of toxic matter in the emissions of the motor vehicle will prove to be shortsighted. In the light of this Nation's engineering accomplishments in outer space over the past 10 years, this objective should certainly not be impractical.

". . . professional engineer, lecturer and teacher . . . quarter of a century in environmental sciences . . . assistant commissioner of health for New York State . . . expert in water and air sanitation . . ."

DISCUSSION

REGULATION OF NEW MOTOR VEHICLES

ALEXANDER RIHM, JR.
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State of New York
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We have heard how the Federal Government, through the Public Health Service, has established motor vehicle emissions limitations for cars and light trucks, beginning with 1968 models; how it is conducting tests of new vehicles, new vehicle engines, and new engine-transmission combinations at its Michigan facility; and how it will issue approvals based on the results of these tests. It may well be asked, however, what will happen once these vehicles are sold to the user.

In New York State, we have taken the view that regulations implementing State law should complement and supplement Federal regulations. Obviously, it is desirable that emission limitations for exhaust required by the States should, if possible, be the same as those established by the Federal Government. To have them otherwise could bring chaos to the automotive industry.

But Federal regulations have not made provision for enforcement of emissions limitations during the life of the vehicle. This, then, becomes a responsibility of the States if they are to reap the benefits of these controls. Federal regulations do require that, before approval, emissions testing must indicate that standards will be met during a lifetime equivalent to 100,000 miles. But during actual use, many things mechanical can go wrong with the devices intended to limit emissions. Therefore, to assure proper operation of the devices, periodic inspections will have to be made.

New York State law now requires annual inspection of motor vehicles, including inspection of emission control devices as soon as satisfactory means can be developed to determine whether or not such devices are performing as intended. Acceptable inspection procedures are being developed in cooperation with the Department of Motor Vehicles, which will administer the inspection program.

On August 1, 1966, Governor Rockefeller signed an amendment to the State's Motor Vehicle and Traffic Law. The Air Pollution Control Board now has the responsibility for promulgating standards for motor vehicle air contaminant-emission control systems with due consideration being given to applicable Federal laws and regulations.

The State Commissioner of Health now has the responsibility of approving or disapproving devices offered by the manufacturers to meet the limitations requirements. By another revision of the Vehicle and Traffic Law, the Department of Motor Vehicles was charged with the responsibility for annual inspection of emission control systems.

Formulation of emissions standards for New York State was not entered into lightly. A council of technical advisors, having automotive competence, was selected and invited to assist our staff. Representatives of the industry (both manufacturing and dealership), of the Public Health Service, and of the Department of Motor Vehicles, gave freely of their time and talents in presenting a reasonable set of standards to the Air Pollution Control Board for consideration. These standards, which we are adopting, will soon be the subject matter of a public hearing, as required by law, prior to adoption. The proposed State standards differ slightly from the Federal standards only in some minor details. For exhaust standards there is no difference. Federal exhaust standards are dependent on a definite testing procedure. It is expected that the State Commissioner of Health will approve or adopt the Federal testing procedure.

Thus, vehicle and engine manufacturers should be able to submit photocopies of their applications and data submitted to the Federal Government and a photocopy of the Federal approval in order to gain New York State acceptance on exhaust emissions. It is hoped—in fact, it is essential—that the Public Health Service will make available to the States copies of its own laboratory test data to assist them in evaluating the data supplied by the manufacturers.

Standards for crankcase emissions in New York State will differ somewhat from the Federal standards, which require return of all blowby to the induction system during the first year of vehicle operation. Since production of 1965 models was started, New York State has been requiring return of at least 80 percent of the seventh decile blowby to the induction system. The new standards are expected to require control of at least 80 percent of the weighted tenth decile blowby.

When all vehicles in use are eventually factory-equipped (as a result of the removal of unequipped vehicles through natural attrition), we shall be controlling all crankcase emissions from more than 90 percent of our vehicles, and most of the crankcase emissions from the remainder, during their entire lifetime.

Federal regulations have not included diesel engines, but many of our most vociferous complaints from the public involve these sources. Heavy black smoke is noticed from diesels on the road and when idling, especially at bus and truck terminals, and this has prompted the Board to consider standards for these two offenders. We propose to limit emissions from diesels so that the density of smoke which will reduce transmission of light by more than 20 percent will be permitted for no more than five seconds at a time. Idling of buses and trucks will be restricted to no more than three minutes in any one period when the vehicle is not performing its intended function as a source of motive power. An exception, of course, would be when vehicles are in traffic jams under conditions over which the operator has no control.

New York State problems from the motor vehicle are centered mostly in the metropolitan and urban areas, where rapid rate of growth during recent decades has been concentrating more and more people and vehicles. Only last month, during the Thanksgiving week, New York City lay for several days under a serious stagnant air mass. The carbon monoxide hourly peak of 35 ppm was reached during the evening of November 21 at the East 121st Street laboratory of the New York City Department of Air Pollution Control. Higher but undetected levels may have existed elsewhere in the city in the vicinity of high-density street traffic.

A voluntary curtailment of automobile use was requested during this episode, but actually there was no way of measuring what if anything this accomplished. We do know, however, that a level of 35 ppm or more of carbon monoxide is more than we care to live with and that drastic action is needed to control this problem, which is created principally by motor vehicle exhaust. We are examining this matter quite closely and are hoping that real progress toward its solution can be made in the near future in cooperation with Federal, regional, other State, and municipal agencies in the metropolitan area.

Other cities, such as Buffalo, Niagara Falls, Rochester, Syracuse, Albany, Binghamton, and Elmira, have all experienced temperature inversions and stagnant air masses. They are all vulnerable, and may be subject to dangerous levels of pollution from motor vehicle and other emissions during the years needed to achieve control.

We need to know more about the actual motor vehicle emissions in our cities, and toward this end, research on emissions and driving cycles is being planned in New York State. We may find that New York State will need lower concentrations of contaminants in exhaust than are required by Federal standards.

A conference scheduled for January 3, 1967, by the Secretary of Health, Education, and Welfare will consider recent findings concerning sulfur oxides and carbon monoxide as they relate to the New York-New Jersey interstate air pollution problem. This action was initiated by Governor Rockefeller on behalf of New York State in October, 1965. The scope of the conference was later expanded by action of Secretary Gardner. The conference will also concern itself with point sources of air pollution. We are hopeful that the recommendations forthcoming from this conference will provide guidelines for solving the problem of carbon monoxide from motor vehicles not only in the New York metropolitan area, but also in all major metropolitan areas where this problem exists.

During 1967, we plan to start the installation of a 50-station air monitoring network in New York State. Air quality will be monitored continuously at each station and concentrations of many contaminants, including carbon monoxide and hydrocarbons, will be determined.

Collected data will be telemetered at 15-minute intervals to a data reception center, including an on-line computer, in Albany. The design anticipates future inclusion of a warning system which will be activated automatically when contaminant concentrations approach dangerous levels. Thus, we shall be able to follow meteorological conditions and the rise and fall of contaminant levels across the State and be in a better position to alert individuals and industry.

Federal exhaust standards are based on average test results from a group of vehicles rather than from individual vehicles. Assuming a normally distributed population, about half of the approved vehicles could be expected to have emissions within allowable limits, while the other half would have emissions above the mean or outside the allowable limits. This means that the States, from a practical standpoint, will be unable to analyze the exhaust gas from individual cars at annual inspections, and as a result, cite any individual owners for violation of the standards. On the contrary, the States, for the time being, will have to be content with cursory inspection of system components—perhaps, for example, in accordance with a procedure prepared recently by the Automobile Manufacturers Association. It is conceivable that a vehicle could pass such an inspection, but have plugs and points so burned or fouled that combustion efficiency would be low, resulting in high exhaust concentrations of carbon monoxide and hydrocarbons.

We in New York State urge the industry to develop exhaust controls so that standards can be written for individual vehicles. It is only in this manner that more than 50 percent of the owners will get what they are paying higher vehicle prices to obtain.

". . . Dean of the California State Senate . . . leader in transportation legislation . . . member of the President's Highway Safety Conference, the Board of Managers of the Council of State Governments . . . known as Father of the Freeways . . ."

REGULATION OF USED MOTOR VEHICLES

RANDOLPH COLLIER
California State Senator
Yreka, California

As I look out in the audience today, I see people whom I have had in my office to talk with me about this problem of air pollution. In the 28 years I have served in the California Senate, I have encountered no other problem that had so many facets as this one. I recall, back in '45 and '46 and '47, trying to get 1 billion dollars together to build a highway plant for California. I recall the problem we had when we more than doubled the highway patrol, from 2.850 men to 6,000. I recall many other problems in the highway field; none of them had so many facets as this problem has.

Even our fights with the petroleum industry and the trucking industry to get more money for highways were not as difficult as this. This problem of air pollution I have always looked upon as a health problem, and because it is a health problem the motor vehicle becomes a health problem too. In California, we have now about 11 million vehicles upon our highways, and we are planning highways so that by 1980 we can accommodate 22 million; and by the year 2000, how many and what types of vehicles will we have?

I took a California Senate subcommittee to Detroit last January, and I see here some of the people who were so kind to us there. We spent two days going through the plants of the four big companies to see what they were doing about air pollution control. The committee felt that the motor industry was doing a tremendous job in trying to solve this problem. The committee, in its report, so stated, but the members felt that in the field of safety the automobile industry was a little lax.

I see people who are interested in this problem from a health standpoint with cigarettes under their noses and, as a nonsmoker myself, I often wonder if they don't get more pollutants from their cigarettes than they do from the automobile.

The 11 million automobiles in California burn almost 20 million gallons of gasoline every day. The relative inefficiency of the internal combustion engine results in nearly 10 percent of that fuel being wasted. That's 2 million gallons a day. Or a yearly wastage of 730 million gallons of motor fuel.

In cost alone, that represents nearly a quarter of a billion dollars. But, more important for the health and welfare of our citizens, that 730 million gallons a year is aerial garbage that our citizens have to inhale with every breath they take—to say nothing of the damage to field crops and livestock which is now so noticeable in the agricultural parts in California.

How do we deal legislatively with a problem of such gigantic proportions?

Because of our California law, 6½ million of our vehicles are now equipped with crankcase control devices, and 900,000 are equipped with exhaust control devices. With these devices we save the equivalent of 330,000 gallons of pollutants per day by curbing hydrocarbon emissions from the crankcase and 120,000 gallons of pollutants per day by curbing emissions from the exhaust, for a total hydrocarbon emission prevention of 450,000 per day. In addition, 2,100 tons of carbon monoxide emissions are prevented per day through exhaust control.

The vast majority of our new vehicles are equipped with these controls; but what about the used motor vehicle controls?

Sitting as I do on the legislative committee, I hear some astounding reasons why there should not be any controls upon the use of the motor vehicle. We hear about the poor old lady who uses a car once a week to go downtown for groceries. We hear about those who are on welfare away out in the country and have to get to town some way. We hear about the farmer who never comes into the metropolitan area; why should he have to put on these controls and incur all this expense? We hear that the motorists already have all the burden they can bear, and I do agree to that. You listen day after day to all these complaints and still have to find some way to bring about legislation that will help the health of the community and the State.

In California there are 12 counties which have functioning air pollution control districts, but used car owners in two of those counties are not subject to the used car provisions of our law, and owners in half the land area in two other counties are also exempt.

These exemptions were political decisions based on the urgent requests of legislators who represented those counties in the legislature when our basic air pollution control bill was passed. That was Senate Bill 317, passed in the 1965 session. Of all the legislation I have handled, this was the most difficult. It not only affected the people's health, but also had a great economic bearing upon everyone in the State. You can imagine the public interest—with everyone wanting fresh air, but not wanting to spend any money.

We found out also that attrition was too slow in disposing of old automobiles. American automobiles seem to be so well made that you can hardly get them off the highways. I was hoping that we might get them off in California because of safety standards, but they don't go to pieces fast enough; our American ingenuity has built them too well.

Now, with reapportionment placing control of both houses of our legislature in urban areas, there may be moves to include currently exempt counties in the used car control program. Additionally, the basic concept of control probably will be reconsidered, and if so, this would mean that more than the 12 counties could be included.

This brings up the question of whether or not a used car control program is really necessary.

This is not meant to startle anyone—administrators, industry, people or public health officials. But consider the cumulative benefits of the new car program; consider the attrition factor in getting some of the old vehicles off the highways. And consider the practical political problem of getting a used car control program through a State legislature—even after reapportionment.

Although motor vehicles constitute the most important remaining uncontrolled contributor to air pollution, complete control of motor vehicle emissions is not technically or economically possible, at least not at the present time, and not with the internal combustion engine.

And this is where politics enters: economically, it may not be possible to require owners of older cars who plan to keep their vehicles to equip them with exhaust or crankcase devices. In my rural area, for example, we may face a taxpayers' revolt very soon; our recent California election illustrated in part the property owner's concern, even though it was a comedian who went about the State reporting that concern. During the years to come, we may not be able to require used car owners to expend money to equip their cars—even though we know that air pollution is a health problem. It is not only a health problem; it's also an economic problem.

There are practical political problems we must face and solve if we are going to have proper legislation on this subject.

". . . corporate leader instrumental in developing devices to control air pollution . . .

DISCUSSION

REGULATION OF USED MOTOR VEHICLES

RICHARD P. SEELIG
President, Chromalloy American Corporation West Nyack, New York

I agree with the premise that both smoking and air pollution are harmful, but the difference is that the smoker primarily hurts himself if he chooses to inhale; whereas if I drive an automobile which belches noxious gases into the atmosphere, I hurt not only myself, but also my fellow man.

It is not my intention to make light of my subject. In fact, I suspect that some of the things that I am going to say may be upsetting to some of the people here. However, in order to avoid becoming too serious, allow me to read from a recent United Press news item from Japan, which proves that the automobile industry doesn't have a monopoly on providing us with pure air. Under a headline, "A Whiff of Fresh Air—30 Cents," and a Tokyo dateline, the article says: "On Tokyo's smoggy Ginza it is now possible to order a pure oxygen cocktail at a plush tearoom . . . Thirty cents gets a customer 15 minutes' use of an oxygen mask—a welcome relief from the choking traffic fumes outside. The manager of the tearoom says he has been getting about 15 orders a day for the mask since it was added to the menu. . . ."

Having visited Tokyo, I can add that great city to the number of places that have a serious smog problem.

My comments officially pertain, however, to used motor vehicles. There is little doubt that control of used vehicles presents a most formidable problem—much more difficult to solve than that for new cars, from the administrative, political and economic points of view, as well as the technical, as Senator Collier has pointed out.

Eric Grant in his introductory remarks says that there is opposition to the present Federal program from people who say: "This is utter nonsense—we don't need it." I take the opposite point of view. I feel that not enough is being done in that program.

Dr. Middleton said in his paper that in about five years, with many of today's used cars disappearing from the highways, the program will show positive results. I think he is overly optimistic.

Mr. Griswold said that there is a runaway problem in California which will not be curbed by current measures; and that there is a faster deterioration of the new-car control system than had been expected. From everything I hear from people who are knowledgeable in these areas, I can emphasize that there are still serious problems to be solved.

Let me discuss now the used-car problem as I see it. With new cars, the hardware can be designed and built from scratch to do the required job. If necessary, the entire engine system can be redesigned, as was the case with the air injection systems installed on new 1966 and 1967 cars in California and those to be installed in the 1968 cars nationwide. All the customer is aware of, if indeed he is aware of that, is that his car costs him from $25 to $50 more than it used to when these devices are installed. And I daresay many a purchaser is not aware that there is a change in his car, until perhaps after he drives the car and finds the performance less satisfactory than he got from his 1964 cars, say. I understand there have been such complaints already. But by and large, the installation of new-car devices is relatively painless as far as the new-car buyer is concerned. Even if he notices the $25 or $50 additional charge, it isn't an immediate thing, since most people finance the purchase of their cars.

With the used car, however, first the technical problem is greater. The hardware must be added to a myriad of cars in an almost infinite variety of configurations, and in all shades of mechanical working order, from good to barely operable. Yet to be economically practical, the control system must be relatively standard and simple to install.

Assuming that this obstacle can be overcome—and I think the 1964 approval of the Chromalloy "Smog Burner" exhaust emission control system proves that it can be overcome—you have to face the formidable problem of requiring the motorist to bring his car into a service center to have the equipment installed and then to pay for it out of his own pocket right then and there.

Incidentally, in connection with the "Smog Burner" I mentioned, credit should be given to the American Machine and Foundry Company with whom we were in partnership at that time and who were largely responsible for having pushed through the approval program.

To the used car owner who has to install a control system, the $65 cost, which is the maximum allowed under the present California law, in some cases represents a large percentage of the total value of his automobile. People will not be too happy about having to pay, for example, $65 extra on a $250 car. Unfortunately, the general attitude of the public towards air pollution has been one of apathy, except during times of severe irritation, like those we recently observed in New York. Then, when the motorist is suddenly confronted with the requirement for a cash outlay, the situation becomes politically explosive and those responsible for its solution tend to shy away from it.

The task then is to persuade the citizen that the rewards are proportional to the pain. To illustrate, let me use California as an example. Figure 1 shows the effect of the new car systems that are now a requirement in California. The dotted line going high up on the right-hand side is the hydrocarbon pollution that would exist in California if there were no control program at all. Don't misunderstand me; I am very appreciative of the State of California for having forced through this program of new-car control. But you will see from the curve, Trend and Projection for Hydrocarbon Emissions Based on the New Car Control, that until 1970 there will be practically no improvement. The bugaboo is the fact that there are, as Senator Collier pointed out, 11 million cars on the roads in California, and only about 600,000 new cars will come into the State the first year. Not all of these will be equipped with devices because they are so-called immigrant cars which are not controlled at the present time, and will only be controlled when the new Federal law goes into effect. The curves are based on the assumption that the new-car devices as they are installed continue to work in accordance with specifications for a number of years. This assumption is not necessarily to be taken for granted. As baselines for comparison, there is the 1940 level of hydrocarbons and also the 1956 level. Things are going to get worse before they get better.

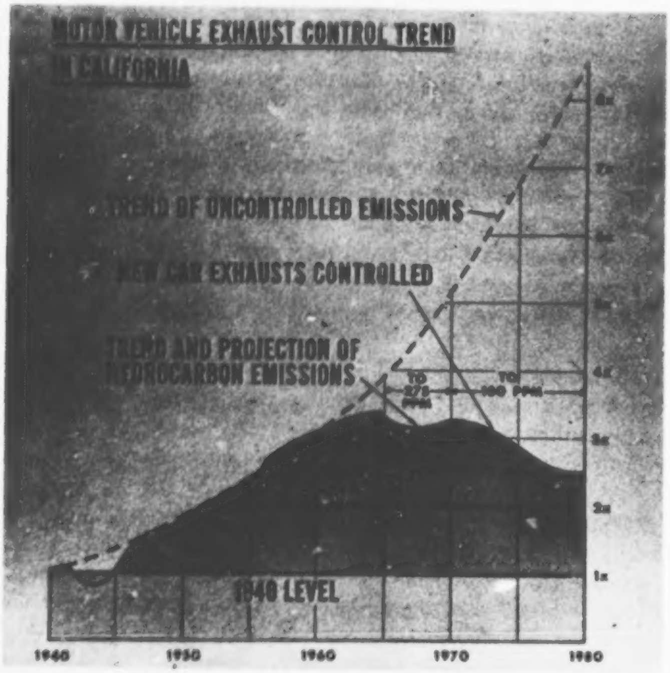

FIGURE 1

Notice in figure 2, however, what happens when used cars are controlled: a purification effect in the atmosphere would be noticed in about three years, or possibly four, whereas we contend that it will be ten or 15 years before there will be an important impact as a result of the new-car control program.

Regardless of these facts, which we feel are dramatic, there remains a great apathy, a hesitancy to tackle the sensitive used-car area, because of fear that adverse public reaction will harm the entire pollution control program. There have been lots of lip service and pious statements, but if one looks at the sorry history of the used-car program in California, the problem remains quite clear—and quite unsolved. We have seen irate citizens kicking in the doors of the Motor Vehicle Bureau; we have seen repeated changes in the legislation; and we have seen repeated changes in the test criteria as applied to used cars. As a result, the used car control program in California has come to a virtual halt. Unless these conditions change, the investment of millions of dollars by firms who are interested and are prepared to enter this field cannot be put to constructive use.

Yet I don't want to be purely and entirely critical. I think there are ways of doing the job. It will take a measure of courage and some imagination. The law governing used cars as it now stands in California represents a very courageous step forward. But I predict that some guarantees will have to be given against further changes in criteria, test conditions, and so forth, before any company will make the vast investment that is required to try for qualification to set up the manufacture and to establish a distribution system for used-car exhaust-purification devices.

A farsighted and courageous approach is also needed to overcome the public's resistance to the sudden cost it is being called upon to incur. We have proposed the implementation of the used-car purification requirement by calling for installation of the system only at the time a car changes ownership. In this case the cost would become part of the purchase price. As stated, this will probably still provoke much opposition because of the high percentage of the purifier cost to the total value of the used car. Therefore, we are recommending another solution. This is based on precedent in California in an entirely different field of public concern.

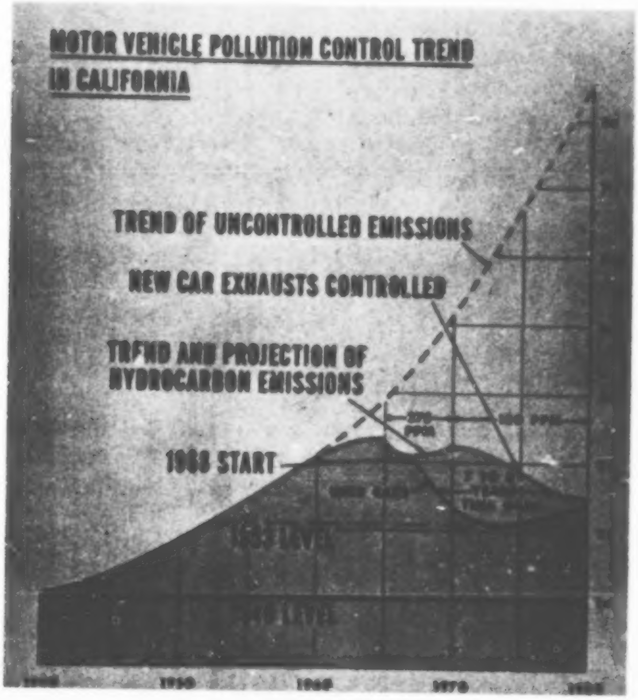

FIGURE 2

During the tragic floods of 1964, northern California suffered great damage to highways and bridges. To raise the money required for repair of this havoc, the State raised the tax on gasoline one cent per gallon until the necessary sums were attained. One cent per gallon represents revenue of over $70 million per year. Thus, all the motorists in the State, the people who use the roads, paid for the damage. There was no violent public outcry, and in fact, this solution was rather painless.

There are other precedents for public support for problems involving public health, such as water purification and beautification. What is wrong with applying similar approaches to the automobile air pollution problem? The cost to the motorist becomes directly proportional to the gasoline he uses and thus to the pollution he creates. I'm now talking about a gasoline tax on a per-gallon basis. It would be relatively simple to establish an installation schedule over a reasonable number of years to allow for smooth handling of the huge number of cars involved with a minimum of installation stations and a minimum of problems in effecting the installations.

Painlessly, the greatest single contributor to smog in California and throughout the country, emissions from the automobile, is eliminated by this technique. The savings accruing to agriculture alone, where damage from smog costs have been estimated at over $100,000,000 a year, would probably offset the annual cost of the program. Perhaps there are other good methods which can be applied to solve this politically sensitive, but highly serious, problem. The government has accepted responsibility for other programs with similar problems such as water purification, resource conservation and landscape beautification. Why, then, not commit the citizenry, through its government and by means of taxes, to the total solution of this problem which involves health and perhaps survival?

We are dealing with a menace to the survival of the human being. As such, it requires strong medicine and must be elevated from the business-as-usual, or politics-as-usual, "let's not rock the boat" attitude. This is one boat that needs rocking—and I would urge the Federal Government to apply this kind of thinking to this nationwide problem and to take on the task of "boat rocker."

QUESTIONS AND COMMENTS

CHAIRMAN GRANT: First, I have a question for Dr. Middleton: You advocated reducing new-car standards even below the proposed 1970 California standards. Do you really believe that new-car owners should bear what is almost certain to be an even greater financial burden in terms of new-car equipment and proposed maintenance costs before at least the greatest possible control is applied also to used vehicles?

MIDDLETON: I think the cost of the control system is negligible when one is concerned with the public health. The cost of the present devices being sold in California amounts initially to about a half cent a mile. If the car is a ten-year old one, this means that, over the average life of a car, ten years, 100,000 miles, the cost of devices on cars today amounts to a little less than a mill a mile. It seems to me that twice that cost would be nothing compared to a return to quality air and the possibility of a longer life for all of us. Whether there is technology today to achieve this is quite another question. The cost certainly is unimportant.

GRANT: This is a question for Mr. Griswold: Would it not be fairer and more effective to control vehicle emissions on the basis of pounds per vehicle-mile, with steeply rising taxes or penalties in proportion to the amount emitted rather than the present concentration basis?

GRISWOLD: The Federal Government standards for 1970 contemplate a weight-of-emission basis which will, in essence, limit emissions from all vehicles to the same amount, regardless of the engine displacement size. The method you suggest would be most difficult to accomplish, for you would have different charges for practically every different model of car and have to change them with every engine according to its pollution potential.

GRANT: The next question is for Senator Collier, and it's certainly appropriate that a legislator should be requested to respond to this one, Senator. Has an investigation been made into the use of a fee for dumping into the air? With automobiles, for example, the license fee could be, say, $25 to $100 more per year if a car does not have proper pollution-control devices added, and in proper working order.

COLLIER: The testimony before our committee in California during the 1965 session did not include any such idea and it was not discussed. We had trouble enough getting our bill through without talking about putting any more burden on the motorist, particularly since the newspapers in California were not in favor of doing anything about emissions from used cars. We even had to cut back the number to be controlled by starting with the year 1955. In the 1965 session I had three bills. One of them called for more than doubling the highway patrol, from 2,850 men to 6,000, with $60 million to support it. Another was on random inspection of automobiles and the third was on air pollution.

After weeks of hearings on the pollution bill, I felt that I could move the other two bills; so I took the pollution bill through the Senate and finally, in the Assembly, I inserted the other two bills in it. The Lower House, which represented the urban areas of California, was interested in the pollution part and there was little discussion on the increased patrol and the $60 million or the random inspection. When the bill came back to the Senate for concurrence, the Senators were interested only in the increase in the highway patrol. I think that's what saved the pollution bill and you can see that it was a tremendous task to get it passed, without talking about license fees for motorists.

This is the first time I've heard of a measure to tax those who put pollutants in the air. It's a question of whether you can get the general public to agree to it. It seems that the Federal Government is able to increase the gasoline tax almost any time it desires, while on the State level we seem to have a great deal of trouble. We raised the gas tax in '47 and '53 and '63 and '64, but it's not a pleasant job to propose any kind of increase in taxes.

If you put another charge upon the motorist, the matter will be fought by the petroleum industry, by the trucking industry, and by the people that own the cars. It's just too bad that attrition on cars isn't greater than it is; otherwise, we could get rid of the worst offenders faster, as they were replaced by new cars.

No one seems to be against raising the prices on new cars because most people buy cars on the installment plan, including the smog devices. They don't seem to resist that, but I think that there would be great resistance to any type of user fees for the elimination of pollutants.

GRANT: We have a rather pointed question directed to Mr. Rihm: Does the dynamometer cycle proposed for certification of exhaust control devices in New York State differ from the proposed Federal cycle, and if so, what are the differences?

RIHM: The answer is no. We are proposing that the Federal procedures be adopted just as they are. We are in the midst of negotiating a contract to study the whole testing procedure and, particularly, the driving cycles in the metropolitan areas. If any occasion should arise for changing these testing procedures, we will reexamine this entire matter.

GRANT: The number of presentations that were prepared for today and solicited by comments and observations indicate that vehicle maintenance is a very important factor in the overall problem of emission control, particularly as it relates to the exhaust.

CHARLES N. HOWISON (*Executive Secretary, Air Pollution Control League of Greater Cincinnati*): I want to emphasize the responsibility of car owners for the proper maintenance of vehicles to reduce needless air pollution. One factor which should receive more consideration is the need for a continuing educational campaign directed to the owners of motor vehicles that would stress the several problem areas and offer suggestions as to how the individual motorist can make his car stop smoking. Or, what is even more important, prevent it from smoking in the first place.

Such a campaign should be actively promoted by the Automobile Manufacturers' Association and by the respective manufacturers of automobiles, through news media and advertising campaigns. In stressing safety, they should also offer the assistance of the thousands of car dealers in maintaining air pollution control devices. In this way, all motorists would be helping to reduce needless air pollution and, at the same time, saving money. An automobile engine which is in good operating condition burns up most of its fuel, and would release relatively few gasoline fumes and unburned hydrocarbons.

A second important factor is a safety inspection program, at local and State levels, which would help the car owner to detect needed corrections for safe and smokeless operation. For example, there are two safety inspection lanes in Cincinnati and Norwood, Ohio which reject about 24 percent of all cars on the first inspection for one or more of some 28 items checked. More than 9 percent of the rejections are for defective mufflers and excessive visible exhaust emissions.

For the year 1965, there were 166,441 semiannual inspections. There were 109,869 rejections at the first inspection. Of this total, 10,442 cars were rejected for having defective mufflers and excessive visible smoke emissions. This would check out to a rejection of 2.3 percent of all inspected cars for these causes.

During the past three years, more than 31,000 cars with defective exhaust emissions or excessive visible emissions were rejected on the first inspection of the vehicle at the two stations. The vehicle had to be adjusted, serviced, or repaired within 30 days and returned to the inspection stations for reinspections. We have found this to be an effective means of reducing exhaust emissions from automobile vehicles. Regardless of how a car is engineered or how efficient its operation when it comes off the assembly line, it can lose this efficiency unless proper maintenance requirements are observed.

The educational campaign should be started immediately. This could help to bring about the second program, more local safety inspection systems.

Our League also urges that the U.S. Pubic Health Service get behind this program for protective maintenance of vehicles as a means of reducing needless air pollution from excessive exhaust emissions.

GRANT: We have a question for Mr. Seelig: If a special one-cent gas tax were imposed, why should a new car buyer be further burdened to pay for a used car device every time he fills his gas tank. Shouldn't the tax also pay for the new car device? This would seem to me to provide more equitable across-the-board application.

SEELIG: This is a very reasonable question. I am not a legislator; I'm an engineer and a businessman. My assigned topic was used cars and I limited myself to that. My purpose in presenting the talk was to throw out a challenge and not necessarily to find pat answers for solving the problem. I simply cited this gasoline tax as one possible way of skinning this cat.

Now I should like to take advantage of having the mike at the moment to correct an omission that I meant to explain earlier. I meant to say that the curves in my slides are based on the assumption that the new-car devices as they are installed continue to work in accordance with specifications for a number of years. This assumption is not necessarily to be taken for granted.

GRANT: Dr. Blomquist, it's your turn now to respond to one that may be a stickler: How does a concentration of carbon monoxide at present tolerance levels compare with the concentration of carbon monoxide in the lungs of a heavy cigarette smoker?

BLOMQUIST: This is a little bit out of the automotive field, but I am afraid, not very favorably. I can't give you the specifics.

GRANT: We have another question which I will answer as best I can: How come automotive and petroleum engineers who ought to know the answers are not on the panel firing line? I think the obvious answer is that they're all home working, trying to keep up with the rules and regulations we are devising for them.

ALEX RADIN (*Manager, American Public Power Association, Washington, D.C.*): I believe all authorities agree that motor vehicles powered by internal combustion engines are major contributors to urban air pollution. It is also widely believed by experts that existing exhaust control devices are a short-range and incomplete solution to the problem. All evidence indicates that we must seek alternatives to gasoline-fueled cars, buses, and trucks if we are to successfully combat air pollution.

Electric vehicles may be the answer over a period of years. Battery-operated cars generate almost no fumes, pollutants, or irritants. If fully substituted for conventional autos, more than 50 percent of total air pollution would be eliminated, together with a major health hazard. There are subsidiary advantages such as reduction of noise, fuel savings, and quicker cold-weather starting.

In recognition of the potential benefits from electric vehicles in combatting air pollution, three Senators and two Congressmen this year introduced legislation in Congress to establish Federal programs of research, development, and demonstration aimed at the creation of vehicles capable of performing practical transportation tasks. There are problems to be solved before achievement of really useful electric vehicles on a mass scale in the United States, but the benefits make imperative an immediate escalation of the effort. Federal action is needed to accelerate research and development in this field and put new thinking to work on it.

I therefore suggest, first, that Congress should approve a program of Federal financial support for research, development, and demonstration of electrical vehicles as provided in several bills now pending before the Congress. This was the approach taken with atomic energy, and the date of commercial nuclear power was enormously advanced because of Government underwriting and cash incentives. Such programs, incidentally, served to stimulate, rather than retard, private efforts in nuclear power development.

Second, electric vehicles should be incorporated in current Federal programs and activities. Consideration should be given to the use of electrically-powered minibuses in downtown demonstration areas and circulating in the suburbs to collect visitors to shopping centers. Trackless trains run by batteries could give tourists at national parks a quiet but scenic view of nature. Combination systems with battery-operated city cars, which are driven to central points by commuters and then carried into the city automatically by an electric guideway, deserve closer study. Post Office trucks can be run by batteries. All of these activities should go forward if we are to develop a non-air-polluting means of transportation.

A

December 13, 1966

PANEL A
MOTOR VEHICLES

SECOND SESSION

Chairman Fred W. Bowditch
Chairman, Vehicle Combustion
Products Committee, Automobile
Manufacturers Association
Warren, Michigan

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". . . researcher in engine combustion and carburetion, General Motors . . . engineer in charge of emissions control . . . industry spokesman on regulatory control . . ."

INTRODUCTORY STATEMENT

FRED W. BOWDITCH
Chairman, Vehicle Combustion Products Committee, Automobile Manufacturers Association
Warren, Michigan

Since the last National Conference on Air Pollution four years ago, considerable progress has been made in our capability for controlling automotive emissions. The automobile industry has shown that it is possible to mass-produce cars with a 70 percent reduction in vehicular emissions. Presently, about 10 percent of vehicle production, all California sales, falls in this category.

The experience of producing these vehicles since the beginning of the 1966 model year has emphasized many anticipated and unanticipated needs. Perhaps the two most critical are improved factory quality control and assured periodic maintenance by the customer.

A whole new concept in factory quality control is required to assure proper emission-control performance of new vehicles. The new emission-control systems will require much more restrictive inspection tolerances than before. As a result, new methods of controlling production variations must be developed. This is a complicated process involving a special technology. Present practices for California vehicles require considerably more individual adjustment than can be tolerated for total production.

Field experience in California emphasizes the need for some form of assured periodic maintenance if effectiveness of emission control systems is to be maintained. All control systems depend for continued performance on periodic maintenance of the type presently performed by the average motorist, who wants continued dependability and performance from his car. To assure that this maintenance is performed on all vehicles will require some form of mandatory maintenance. Until such time as satisfactory inspection instrumentation becomes available, periodic maintenance appears the only effective approach to this problem.

The ability to manufacture emission-control systems of such a substantial nature has not come easily. Since the last National Conference on Air Pollution, we as a technical community have learned much about the relative importance of the various sources of automotive emissions—much about the composition of the emissions from these sources. We also have learned a great deal about the effect on emissions of engine-design factors as well as engine-operating variables.

While no one of these areas of information totally solves the problem of how to control automotive emissions, they all constitute necessary portions of information which must be available before effective control systems can be designed for manufacture. Without this approach no effective system can become a reality.

The success of the automotive emission program as part of the general air pollution abatement program depends, from the viewpoint of both industry and regulatory agencies, on how well this information has been developed. The public will be the final judge.

If more restrictive automotive emission standards are necessary in the future and if such controls are feasible, the automotive industry will certainly step up to its responsibility. To expedite the implementation of any new requirements, both in terms of time and in terms of minimum customer cost, assistance from regulatory agencies in two areas is needed.

First, since major technical problems remain to be solved before substantially more effective emission controls can be designed, the publication of new requirements should be made as soon as practicable; not only must more technical information be generated but the most effective control system cannot be designed until its exact function can be defined. There remains the matter of lead time in terms of manufacturing requirements once the control system design is finalized. Any reduction in lead time results in an unsatisfactory product, either in terms of cost or in terms of performance. The automobile is one of the most complicated of mass-produced commodities—lead time is an essential ingredient to the success of that product.

Second, the maximum cooperation between regulatory agencies is an absolute necessity. Presently, several of the States are considering automotive emission-control requirements which are not identical to the Federal requirements. Proliferation of this approach leads to an untenable situation. Not only does it dilute engineering effort for development of control systems, but it also means unreasonable cost for the systems. A minimum of variation in requirements is in the best interests of the public, the industry, and eventually the regulatory agencies themselves.

". . . started with Chrysler Corporation in 1933 as a student engineer . . . today vice president and director of engineering with same company . . . trustee of Detroit Institute of Technology . . ."

PRESENT APPROACH TO CONTROL OF MOTOR VEHICLE EXHAUST EMISSIONS

B. W. BOGAN
Chairman, Engineering Advisory Committee, Automobile Manufacturers Association, Detroit, Michigan

I appreciate this opportunity to describe to you the present approach to the control of automobile exhaust emissions.

As you know, all new passenger cars and light trucks built in this country for sale in California are equipped to control hydrocarbon and carbon monoxide emissions from both the crankcase ventilation system and from the engine exhaust.

Emissions from the crankcase system are controlled by routing all of the crankcase gases back into the engine for further processing. This is accomplished through connections from the crankcase breather outlet to the engine intake manifold and from the oil inlet to the air cleaner. Such a device was installed on all new 1961 models sold in California and was extended nationwide on 1963 models.

Exhaust emission control is achieved by improved processing within the engine itself of both the crankcase gases and the regular combustion gases. This is accomplished by modifications to the induction systems, the combustion chamber, and timing of the engine. In addition, some systems provide secondary air for further combustion in the exhaust manifold. These controls have been in use in California on 1966 and 1967 models. They will be extended nationwide, beginning with the 1968 models. As a result of these controls, pollutants have been reduced by approximately 70 percent.

Very briefly, I have described the present approach to the control of automobile exhaust emissions. To emphasize the significance of what I have said so far, I will describe—again briefly—how this remarkable achievement was brought into being.

In my opinion, it is far more important to examine what we had to do to arrive at the present approach than it is to describe in detail the current systems for controlling emissions. It is my hope that this examination will help indicate ways to avoid problems in the development of advanced emission control systems.

It took about 13 years of development work by automotive engineers to reach the present level of control of motor vehicle exhaust emissions.

To the casual observer, I suppose 13 years would seem to be a long time. However, there were many obstacles that had to be overcome. New technology had to be discovered and, then, systematized for consistent application. I believe that when these facts are known, the automotive industry and others working on this problem will be commended for their resourcefulness.

It is a tribute to the determination of scientists and engineers from industry and government that today's achievements did not take longer than 13 years. To emphasize that point, I intend to describe briefly four of the major problems encountered. These concerned: instrumentation, information about the pollutants, factors affecting emissions, and development of control devices.

Persons not so well versed in air pollution technology as this audience need to be reminded it was not until 1953 that the automotive industry was made aware of Dr. A. J. Haagen-Smit's theory. He proposed that oxides of nitrogen and hydrocarbons can react photochemically in the atmosphere to create eye-irritating, plant-damaging compounds. This type of air pollution was considered to be the primary problem in the Los Angeles basin.

Once again, I think that those of us who have some understanding of air pollution need to remind others that the Haagen-Smit theory was not universally accepted at that time. So, we began with a controversial conception of what the air pollution problem consisted of in the Los Angeles basin.

The automotive industry sent two teams of technical personnel to California to discuss the theory with others who were studying it. The teams concluded there was a high probability that Haagen-Smit was correct.

It followed, then, that since the automobile was known to emit both hydrocarbons and oxides of nitrogen, it must be a contributor to the pollution problem in Los Angeles. This, in turn, raised questions about the extent of the contribution of motor vehicles and how to reduce these pollutants from exhaust emissions.

When methods for determining the automobile's contribution were examined, they were found to be inaccurate, extremely tedious, and not reproducible. In addition, the sampling techniques were extremely poor.

We immediately sought help in developing adequate instrumentation. The Coordinating Research Council, which is an agency through which the petroleum and automotive industries work on a cooperative basis, initiated a project for this purpose. The study included continuous sampling and analysis procedures for evaluation of exhaust gases to determine the content of carbon monoxide, carbon dioxide, oxides of nitrogen, and unburned hydrocarbons.

As we know, there are large numbers of individual components grouped under the generic term "hydrocarbons." Ideally, the instrumentation required would give instantaneous, continuous and accurate readings, not only of hydrocarbons as a group, but also for the values of the many hundreds of individual components. Therefore, as I am sure you will agree, the assignment was far from a simple one.

The analytical tools available at that time included the dispersive infrared equipment, the mass spectrometers for hydrocarbons, the Orsat analysis for CO and CO_2, and wet chemical methods for analyzing aldehydes and oxides of nitrogen. With the exception of the Orsat, none of these had been used extensively in connection with exhaust gas analysis.

To the extent that known methods had been used, serious sampling problems were indicated. In addition, methods were not suited to continuous sampling, at least not in the form that were then available. In spite of these problems, a picture of total emissions from a very limited number of vehicles was obtained.

Late in 1954, non-dispersive infrared analytical equipment was adapted to measure exhaust composition. The equipment was used experimentally during a field survey of vehicles in the Los Angeles area early in 1955. This survey established that the non-dispersive infrared equipment was superior in flexibility to previously used instrumentation. It further indicated that variations between individual vehicles were very large.

The values obtained for carbon monoxide and for carbon dioxide were very satisfactory from the beginning. The hydrocarbon analysis, however, had many shortcomings. It did not differentiate between various hydrocarbon components, nor did it respond to all hydrocarbon compounds. Moreover, in the early stages, it did not give reproducible results.

However, the non-dispersive infrared equipment did provide for continuous analysis of emissions from every kind of engine operation. Major programs were initiated to improve the method. The studies explored, among other things, development of sampling procedures, establishment of precautionary measures, and a technique for calculating the data.

All of this was further complicated, of course, by the requirement of measuring the very low concentrations of pollutants with which we were dealing.

It is significant that until about 1959, opinions varied widely among the various industry and government laboratories on how to use the non-dispersive infrared equipment. It was not until reasonable confidence had been acquired in the use of this analytical tool that any real attempt could be made to develop procedures for evaluating the performance of proposed control devices.

Even today, despite our best efforts and those of others, we do not have adequate continuous analytical methods for evaluating individual hydrocarbons satisfactorily and accurately. The partially oxidized hydrocarbons are measured infrequently because of unsatisfactory techniques. In addition, our methods of measuring oxides of nitrogen leave much to be desired.

Our experiences with the difficulties in obtaining adequate analytical methods have taught us that if additional control requirements are going to be met in the future, suitable instrumentation development must precede the advances we are seeking.

Some of you may recall that in the '50s we heard pleas for reductions of 60, 70 and 90 percent of the emissions from automobiles. While these pleas were dramatic, they unfortunately failed to answer the question: 60, 70 or 90 percent of what? From the meager knowledge available, it was even then apparent that measuring one vehicle did not give the answer and that several hundred vehicles would have to be measured under conditions typical of motor vehicle operation in Los Angeles. This was required in order to obtain the necessary baseline.

The first field survey was made in 1955. This preliminary study was really intended to find out how to conduct such a survey. I point this out just to emphasize how meager anyone's knowledge was on the subject. No one could legislate into being that knowledge; it had to be acquired through the exercise of ingenuity and the learning process of trial and error.

Among the interesting things we learned were: The apparently "flat" freeways of Los Angeles are not level enough and a better test area had to be found; continuous instrumentation was essential to obtain significant information, and the testing of 300-to-500 cars was the absolute minimum for obtaining a reliable sample.

A second survey, which took approximately six weeks, utilized three different types of non-dispersive hydrocarbon infrared analyzers. In addition, the industry had developed analytical equipment for continuous evaluation of air-flow which permitted both the flow and the concentration to be obtained. The operation was conducted on the dry Los Angeles river bed which provided the necessary flat surface. Samples were taken from vehicles which were thought to be representative of the Los Angeles car population.

The mass of data which subsequently was obtained, and the new questions which resulted, were so complex that it was impossible to issue a report on the total operation until early 1958.

Whatever the survey established, it certainly made clear that wide variations in results could be expected from different vehicles under similar operating conditions.

It was generally agreed that additional work needed to be done to measure emissions from cars. In 1959, therefore, the Automobile Manufacturers Association proposed a cooperative program for evaluation of vehicles. Participating were the Southern California Automobile Club, the U.S. Public Health Service, and technical personnel from Los Angeles County, as well as the State of California.

Instead of taking samples from cars in the field, however, the survey group decided to develop a representative cycle on a chassis dynamometer and obtain samples from engines run on the dynamometer. It was necessary, therefore, to conduct elaborate studies to make sure the dynamometer operation duplicated that of typical driving conditions.

As a result, a baseline was established. It is significant to note that up to this point, very few investigators were willing to indicate a baseline for motor vehicle emissions and, therefore, the degree of improvement required.

As was the case in learning a valuable lesson from experiences with instrumentation, which I pointed out earlier, we also learned a lesson in our quest for information. If we are to consider exhaust emissions other than those presently controlled, it now is clear that the existing baseline for these components must be established early in the program. In addition, the baseline must be established using the same techniques which, ultimately, will be used for control legislation.

Moreover, the intensive studies of atmospheric conditions in California provided the information essential to the establishment of air quality standards upon which to base the need for controls. It must be emphasized that much of this fundamental work remains to be done in other sections of the nation.

We now come to our third major problem listed earlier: factors affecting emissions. We are concerned here with the manner in which the vehicles are operated and the amount of air flow utilized by each engine.

Studies to determine typical vehicle operating practices were conducted in conjunction with the Los Angeles Air Pollution Control District and concurrently with the field surveys.

To determine engine air volumes, it was necessary, once again, to have instrumentation which could collect such data. Specialized groups within the Automobile Manufacturers Association, as well as others, undertook the task of creating such instrumentation. Equipment was developed which gave accurate portrayals of the flow conditions. However, it required specialized installation and did not lend itself to quick evaluation of a customer's vehicle.

Therefore, an average air-flow figure for each type of operation for use with all vehicles, regardless of their flow characteristics, had to be adopted. This obviously left something to be desired, but did permit a useful evaluation of the total emissions attributable to the automobile.

All the work mentioned so far, and much more that I have not taken the time to describe, was a necessary prelude to the accurate evaluation of approaches to reducing air pollution and to legislation governing requirements. The lessons from these studies, I believe, are three-fold:

1. Development and regulations must follow a study of the actual conditions that exist.
2. Regulations can become a reality only when the necessary tools for evaluating all variables are developed.
3. Finalization of controls cannot be achieved until precise requirements, usually in the form of regulations, are known.

DEVELOPMENT OF CONTROL DEVICES

We began our work, as so often happens, without sufficient background and knowledge. In this period we developed some 60 usable devices for controlling deceleration of the vehicle in the mistaken belief that this condition caused more unburned hydrocarbon to be produced than all other operating phases of the vehicle. These efforts added to our education even though they did not yield the answer.

Next, we did extensive work in developing flame and catalytic afterburners. Despite the best efforts within, and outside, the industry, these methods of control proved to be unfeasible for various reasons.

This brought us, finally, to realization that it was the engine itself which needed to be modified in order to reduce exhaust emissions. I have already described the successful effort to learn how to do that.

The significant point, however, that must be emphasized is that successful engine modification would not have been possible without the knowledge gained in all of the areas I have described here. If that laboriously acquired information had not been available, it would have been impossible to do the job. This factor of accumulating knowledge until, finally, it crystallizes into usable form, often is overlooked by those who seek instant engineering miracles.

The arduous work of the past—the development of instrumentation, the determination of amounts of uncontrolled pollutants, the traffic and field surveys, and even the false starts on development of devices—contributed to bringing us to the present plateau of controlling emissions from motor vehicles.

OUTLOOK FOR THE FUTURE

This experience certainly will be of some aid in expediting the development of whatever future controls are deemed to be necessary.

In addition, another problem, which requires immediate attention, has been brought into focus. How do we ensure that the control devices that we are about to put on all our new cars will continue to perform at their maximum efficiency?

Applying lessons learned in the past, all of us should be working actively on several aspects of the problem. We need answers to the following questions:

Do we have the necessary instruments to do the job of evaluating performance in the fields? If it is decided that we need regular inspection of control devices on a nationwide basis—as I believe we do—have we adequate equipment in the necessary volume to do the jobs?

Assuming that we are able to do the job of inspection, and we find something needing correction, what can be done about it? Are trained mechanics available in sufficient numbers? What steps can be taken to provide for the training of additional mechanics and, then, making sure they are kept abreast of new developments by means of a continuing education program? Are the necessary aids available for making the mechanic's task an easier one?

In regard to field studies, have we established the frequency of inspection and the types of inspection that will be necessary?

In the field of legislation, have the various levels of government resolved the problems of how to handle mandatory inspection? Are the enabling laws being drafted? Will the necessary funds be appropriated? Have we accomplished the educational job of convincing voters of the need for inspection?

Our past experiences tell us that these questions must be answered affirmatively, if we are to devise a workable system for guaranteeing the continuing effectiveness of exhaust emission control devices.

I believe the lessons which have been learned indicate that, in the future, a program should be followed which includes:

1. A precise definition of requirements in terms of the necessary pollution reduction indicated by atmospheric measurement.
2. A quantitative evaluation of the present contributions of the motor vehicle on a nationwide basis.
3. A realistic evaluation of the economic range in which controls must be produced.
4. The development of instrumentation, precise enough to establish that the necessary control is being achieved and, at the same time, is suited to the needs of development and enforcement.
5. The establishment of physical knowledge in such fields as reaction studies and materials development.
6. The development of control mechanisms which are not inconsistent with other control objectives.
7. The establishment of mandatory maintenance and inspection procedures to make sure that exhaust emission control devices continue to operate at maximum efficiency throughout the life of the vehicle.

If this conference and similar gatherings generate adequate information and programs to achieve these objectives in an orderly and expeditious manner, I am confident we will be able to produce the next generation of controls more rapidly. It will be understood, then, that our past experiences really have been a prologue to future progress.

". . . engineer, scientist, researcher in pollution control . . . directs PHS research in chemistry, physics, engineering of air pollution . . . directs national air monitoring networks . . ."

DISCUSSION

PRESENT APPROACH TO CONTROL OF MOTOR VEHICLE EXHAUST EMISSIONS

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Mr. Bogan has recounted the trials which all of us in the vehicle emission control area have undergone in the past 13 years. He has brought us to the present stage in the application of such controls—crankcase and exhaust emission controls in California, the latter starting with 1966 model-year cars, and similar requirements nationally to commence with 1968 model-year cars and light trucks.

No one would deny, I am sure, that the automotive industry has contributed greatly to the developments that led to the presently applied controls for vehicle emissions. However, we should all realize that many others—in government, in universities, in private foundations, and in industries other than automobile manufacturing—also have played important roles. They have made direct contributions of knowledge in the many areas delineated by Mr. Bogan, or have provided the pressures and the will to get the job done, a less direct but fully as effective means for attaining control.

Such areas as photochemistry, emission measurements, analytical methods and instrumentation, device development, air quality monitoring, and the setting of air quality and vehicle emission standards, are but a few of the activities to which many have contributed. Agencies such as the Los Angeles Air Pollution Control District, the State of California, the Air Pollution Foundation, and the petroleum industry pioneered in these activities as long as 13 years ago.

Since then, significant contributions have also been made by the Department of Health, Education, and Welfare, by many industries in developing converters and afterburners for control of exhaust, by the chemical industry through their interest in fuel additives, by State and local air pollution agencies, by universities and private foundations that have conducted a large share of the biological effects studies, and by civic groups adamant in their goal of restoring the quality of our air resource.

No one, I am sure, would disagree with Mr. Bogan's statement that the 13-year development period since the discovery of photochemical smog has been a difficult one wherein, many times, new developments were made obsolete by yet later developments that emerged with new technologies. No one would deny that the efforts of these 13 years have found their fruition in the controls applied today.

We hope that we have now passed through this necessary incubation period and have reached a plateau of knowledge and understanding that will allow better, broader, and quicker application of new controls as future needs arise.

These "first generation" controls are impressive accomplishments and are a significant step in controlling air pollution. However, it is interesting to examine them in the light of the substantial increases in pollution sources during these 13 years since the identification of photochemical smog.

The number of vehicles in the United States has increased 64 percent, and gasoline consumption has increased 73 percent since 1953. Such figures indicate that we would have needed a national average overall reduction in all emissions of about 70 percent just to hold the line. The State of California has reported that in Los Angeles County reductions of emissions resulting from control of crankcase ventilation since 1961 and from control of exhaust emissions for one year have been overridden by increases in cars on the road, with the result that hydrocarbon emissions are essentially the same and carbon monoxide has increased 19 percent since 1961.

However, it should be pointed out that application of these controls has now resulted in an overall downward trend. These examples are cited principally to indicate the problem imposed by our burgeoning population and our proclivity for driving more and more automobiles. The result is that much of our gain in reducing emissions is offset by our increased ability to produce more pollution.

Mr. Bogan cited a figure of 70 percent control, which I assume represents the overall effectiveness of crankcase and exhaust control devices now on cars in California. What does this mean in terms of total emissions under normal driving conditions in urban areas where the problem is most severe?

There is little need at this meeting to explore the purpose and adequacy of device certification procedures; these are part of the complicated history of vehicle control which emerged from the early efforts during this 13-year period. The important thing, I think, is to recognize that these procedures do provide the reproducible laboratory tests needed to check compliance to a standard.

At the same time it seems logical to me to assess our accomplishments, not in terms of artificial certification procedures but in terms of "on-the-road" emissions. Also we should consider the effectiveness of present controls in reducing overall emissions from all parts of the vehicles as well as those just being controlled today.

When this is done, the indications are that present controls are effective in reducing about 44 percent of the total emissions of hydrocarbons and about 67 percent of the carbon monoxide; they effect an increase of about 10 percent in nitrogen oxides. The point of all this is that in the light of our coming problems, resulting from more people and more cars crammed into essentially the same urban living space, there is little room to be complacent; rather we should capitalize on our hard-earned experience of the past 13 years and get on with the job of sharpening up our abilities to effect better controls, applying controls to all types of emissions, and assuring that such control devices remain effective over the life of the vehicle.

As Mr. Bogan has pointed out, the task of device inspection is enormous and can be prosecuted most effectively at the State and local level.

Mr. Bogan outlined seven important stages in the development of future control programs. Few of us would deny the logic of his suggestions; virtually all of the items outlined are receiving attention today in a variety of industrial, Federal, State, local, and privately sponsored programs. Mr. Bogan stated, in closing, that "our past experiences really have been a prologue to future progress." I share with him this conviction, and hope that included in these experiences is the understanding that our Nation's progress will be more rewarding if it includes social as well as economic gains.

". . . engineer, professor, researcher, consultant to industry . . . instructor and professor of engineering . . . in charge of teaching and research on vehicle powerplants . . ."

FUTURE AUTOMOTIVE POWERPLANTS—AND AIR POLLUTION

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INTRODUCTION

An urgent need to greatly reduce undesirable exhaust emissions from vehicle powerplants now occupies our attention. As many of you have already stated, the problems relating to air pollution are complex because there are many types of pollutants and several sources of pollutants from the various powerplants. The problem is further complicated by the fact that different areas of the country have different meteorological conditions.

Present automotive engines, gasoline and diesel, have a history of intensive development which extends back into the nineteenth century. There are now 94 million vehicles registered in the United States. Over 90 percent of all installed horsepower in the United States is in motor cars and trucks. The present almost exclusive use of piston engines for highway travel is based on important technical advantages, which will be pointed out very briefly.

To predict the future outlook for the several types of powerplants for vehicle propulsion is a formidable task, but it can at least be approached with greater confidence because of two recent papers. The first is the paper by Welsh,[1] representing the opinions of the Society of Automotive Engineers Powerplant Committee. The second is the report of Brubacher[2] which is in part an industry consensus. My opinions are in general similar to those expressed in these reports.

The future outlook involves an examination of energy sources, power requirements, and powerplant systems for converting a source of energy into mechanical power. Many systems are being suggested, including battery- and fuel cell-powered electric vehicles. Even the merits of the steam-powered automobile are sometimes extolled, which, along with the battery-electric car, competed on a nearly equal basis with the gasoline-engine car early in the twentieth century. The first portion of this paper will consider the more conventional powerplants and the possibilities of reducing their emissions. The last portion will consider more futuristic powerplants for vehicle use.

Size is a very important consideration in choosing a powerplant. Obviously, motorcycles and railway locomotives call for different powerplant solutions. My comments relate particularly to personal vehicle powerplants, and even these vary greatly in size.

ABSTRACT

1. The present types of piston engines will continue for many years to be the main source of power for highway transportation.
2. Major reductions of the undesirable exhaust emissions of present powerplant systems have been made during the last few years and will continue to be accomplished under the impetus of air pollution requirements and regulations.

3. There is a place for battery-powered vehicles in very-small-size and short-range applications, especially for areas with serious air pollution. However, batteries with much greater energy and power density, and at greatly reduced cost will be required before they will achieve significant use. The increased use of central station atomic energy in the future will give added advantages to battery-electric vehicles.
4. Our hope for reducing air pollution from vehicles during at least the next 20 years must result mainly from making improvements in the present types of conventional engines.
5. The fuel cell may be more important than batteries for vehicle propulsion in the more distant future because: (1) it is in an earlier stage of development and (2) it may be able to utilize a hydrocarbon fuel.
6. Any successful program for reduction of exhaust emissions from vehicles must include an effective engine inspection and maintenance program.

ENERGY SOURCES

The mobile or portable powerplant can use any energy source that can be suitably transmitted to the vehicle or stored on board. However, mobility places severe limitations on practical energy sources and powerplants.

The power of the wind served as a very direct and principal source of power for water transportation for centuries. Although sailing is an important sport, it is not competitive for transportation. Similarly, the conversion of solar energy for propulsion requires an area of on-board reflector surface which is wholly impractical, to say nothing about the problems of operation after sundown.

The fossil fuels, including coal, oil, and gas, represent a vast supply of energy on earth, and are presently our principal energy source.

Oil is presently of greatest importance to land transportation, because hydrocarbon fuels, such as gasoline, are highly concentrated sources of energy, and easily transported and stored. Our present rate of consumption of petroleum now exceeds 10.6 million barrels per day, and daily consumption now exceeds the rate of discovery.[3] Although the reserves of oil are large, there can be no doubt that they will eventually be exhausted. It is to be expected that its cost will increase as more difficult fields are tapped.

There are also large deposits of shale rock in the Rocky Mountain Range, and also of tar sands in the United States and Canada. These sources can be used to produce motor fuels, but at increased cost. These are said to provide a reserve supply of hydrocarbon fuels which should last for several centuries.

The supply of gaseous fuel is believed to be much smaller and will probably be depleted much sooner. In view of the unknown supply and the ever-mounting rate of consumption, more attention should be directed to conserving the reserves of oil and gas.

The utilization of nuclear energy in the last generation is one of the great scientific achievements in history, and has made available a vast new source of energy for use. This source is best adapted to stationary use, since many difficult problems of shielding and safety attend its application. However, the nuclear submarine is an outstanding example of the application of nuclear power to transportation, and here it provides advantages not possible with any other energy source.

ENERGY CONVERSION SYSTEMS

There are almost countless ways to classify the many kinds of powerplants. For comparisons of very diverse types, which will include conventional engines and fuel cells, it is helpful to divide them all into two classes,[4] as follows:

1. Those whose method of operation requires that the energy of the fuel, or other energy source, be transferred as heat to a working fluid, which in turn

goes through a cycle. This working fluid is commonly steam. For this type the machine both in theory and practice executes a cycle. Examples of this type are steam engines, nuclear powerplants, and hot-air engines such as the Stirling engine.

2. Those whose method of operation does not require that the energy of the fuel or other source be transferred as heat to a working fluid. This type is concerned both in practice and in theory with processes, and not a cycle. Examples of this type are sparked-ignited reciprocating engines, diesel engines, gas turbine engines, and fuel cells.

The thermal efficiency of the energy converters of type 1 are subject to the Carnot cycle limitation. This involves a principle of thermodynamics which, in general, states that the efficiency of these engines will be increased if the maximum temperature of the cycle is increased.

For the energy converters of Type 2, maximum temperature is not essential to gain maximum efficiency. It is true that for many processes an increase in temperature increases the possibility of doing more work, but this correlation is fortuitous for this type, and holds only over limited ranges and for only some of the converters. The efficiency of fuel cells is commonly reduced if their temperature is increased.

It is also a principle of thermodynamics that all practical energy conversion systems are limited to their efficiency, and cannot convert all of the energy of a fuel into power. The laws of thermodynamics establish the maximum efficiency possible, and this will be reduced by practical considerations. For example, it is estimated that the maximum overall efficiency to be expected from future practical reciprocating engines will not exceed 45 percent. The thermal efficiency of fuel cells is very much related to load, being most efficient at the lightest load. Present fuel cells are usually more efficient than conventional engines. Since they are in an early state of development, it is expected that their efficiency advantage will increase in the future.

PERSONAL TRANSPORTATION IN THE FUTURE

It is to be expected that with the completion of the Interstate Highway System, vehicle speeds for intercity travel will increase. Since the power to propel a vehicle increases as the cube of the speed, this will increase the power required for future intercity vehicles.

Figure 1 shows the power required to propel automobiles of common weights and corresponding sizes at various speeds. As an example, at 70 miles per hour the power required to propel a 3000-pound vehicle is 40 horsepower. If the speed of this vehicle is increased to 80 miles/hour the power required will be:

$$40\times\left(\frac{80}{70}\right)^3=59\text{ H.P.}$$

The future will bring further diversification of vehicle types for special uses, and an even greater range of vehicle sizes and installed horsepower. As congestion in the cities grows, there will be increased need for and use of smaller vehicles for neighborhood errands and shopping. However, a vehicle to travel throughout the Los Angeles Valley will probably not become much smaller than the present range of vehicles.

REQUIREMENTS OF AN AUTOMOTIVE POWERPLANT

An automotive powerplant must meet many requirements to be acceptable. Among these are:

1. *Absence of undesirable exhaust emissions.* This relatively new criterion is listed first to emphasize its present and future importance. The emissions include: carbon monoxide, hydrocarbons, oxides of nitrogen, smoke, odor, atomic radiation, and others. This requirement will have an important effect on engine selection and design in the future.
2. *Size and weight.* These criteria are obviously important, and include the common criterion of maximum horsepower/unit of weight. Vehicle performance, including accelerating ability, will depend greatly on the use of an en-

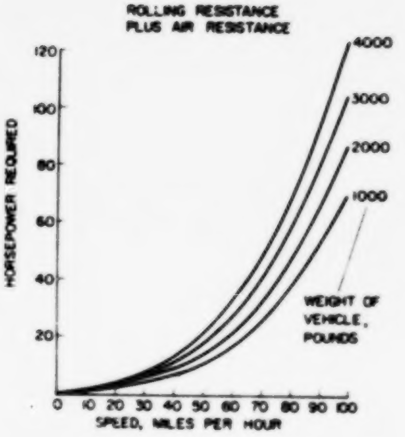

FIGURE 1.—*Power required to propel vehicles.*

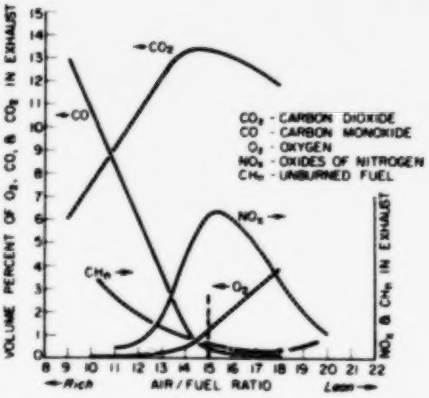

FIGURE 2.—*Composition of automobile engine exhaust.*

gine with high horsepower per unit of weight.

3. *The powerplant* must use a concentrated, low-cost, and easily handled energy source, or fuel.
4. *Minimum fuel consumption.* This is important from the cost standpoint, and affects the driving range of the vehicle between fueling stops. It is also important in the interest of conserving natural resources.
5. *Flexibility.* This includes the ability to operate at all necessary combinations of load and speed with simple power control means, with characteristics suitable for vehicle propulsion (such as high engine torque at low speed).
6. *Low initial cost, simplicity.*
7. *Long life and reliability.* Reliability, low maintenance cost, and long life are increased with simplicity.
8. *Ability to move quickly* from a cold start.
9. *Ability to provide passenger comfort* in hot and cold weather. Summer cooling and winter heating can consume nearly as much energy as is required for average vehicle propulsion in city driving.
10. *Quietness.* The ability to operate quietly will grow much more important in the future, as population density increases. The public is presently being subjected to an unreasonably high level of noise from many types of vehicles.

EMISSIONS FROM GASOLINE ENGINES

A brief discussion of the emissions from gasoline engines will point to some of the factors which influence the emissions and give insight into the general problem of emissions from engines.

Whenever hydrocarbon fuels are burned, at least trace amounts of unburned fuel and carbon monoxide will result. The quantity of these constituents is principally a function of the amount of fuel per unit amount of air, referred to as the air/fuel mixture ratio, shown in Figure 2. There is a theoretically correct mixture ratio of air and fuel which contains precisely the necessary amount of air to burn the fuel, with no air left over. This ratio is indicated on Figure 2 and is about 15 lb. of air per lb. of fuel. With excess air (lean mixtures) there will be some oxygen in the exhaust, and a minimum amount of carbon monoxide and unburned fuel. When there is excess fuel (a rich mixture) there is insufficient oxygen and the quantities of unburned hydrocarbons (fuel) and carbon monoxide are greatly increased, as can also be noted in Figure 2. To reduce these constituents, it is important to run the engine on a lean mixture (excess air).

Unfortunately, the lean mixture of about 16 lb. of air per lb. of fuel, which gives minimum carbon monoxide and unburned fuel, together with best fuel economy, also causes the oxides of nitrogen to be near their maximum value. Oxides of nitrogen are formed whenever air is heated to high temperatures, as in the case of combustion. The problem of their control is very difficult, and a practical solution constitutes an important engineering challenge.

Unfortunately, gasoline engines have needed rich mixtures under many operating conditions to avoid hesitation and/or stalling, and to obtain the desired maximum power and engine performance. Typical mixture ratios used by an automobile engine at idle, part throttle (cruise), and at full throttle conditions, are shown in Figure 3. By referring to Figure 2 for the given air/fuel ratios, the approximate exhaust composition can be determined for various engine conditions. For example, it can be noted that the rich mixture ratio of about 12/1 at idle, produces 6 percent of carbon monoxide, and at this condition will be particularly lethal in a closed garage.

With the urgent need to reduce exhaust emissions, there is now much development activity in the automotive industry to take all possible steps to operate engines with the leanest practical air/fuel ratio at all operating conditions. The industry has never before had such an urgent incentive to improve its product, and I am confident that under this new stimulus, much improvement will be made, and the improved products will also provide improved fuel economy.

I am convinced that the present types of automotive piston engines will be our main automobile power source for many years. Therefore, possible means for reducing exhaust emissions within the engine is of major importance to this conference, and possible means for accomplishing this will be discussed. This is the more important, since it is likely to be the most direct and economical approach to the problem.

REDUCTION OF EMISSIONS BY IMPROVED ENGINE DESIGN

The greatest potential for reduction in emissions in gasoline engines lies in improved fuel and air induction systems and in improved combustion chambers; this discussion will therefore be restricted to this portion of the engine.

The function of the carburetor is to provide the proper air-to-fuel mixture ratio for each engine condition, mix the air and fuel as intimately as possible, and provide means for regulating the engine power. The function of the engine intake manifold is to conduct the wet mixture of air and fuel to all the cylinders, in such a manner that all cylinders receive the same air/fuel ratio. This task is made very difficult because some of the fuel in the intake manifold will be vapor, some will exist as droplets in the air, and some will exist as a slow-moving liquid film on the intake manifold wall. Figure 4 shows the general arrangement of these induction system components.

Brief comments follow concerning potential improvements:

Carburetors. There is need for carburetors that more nearly supply the optimum mixture ratio under all engine-operating conditions, and under all atmospheric conditions. A few examples of needed improvements in carburetors will be given.

Present automotive carburetors run at least 6 percent richer in Denver than they do in Detroit, due to the average difference in atmospheric pressure. The effect of this change of fuel/air ratio on exhaust emissions will vary according to the basic car-

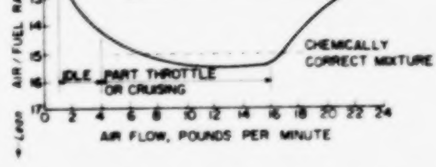

FIGURE 3.—*Typical air/fuel mixture ratios used by automotive engines.*

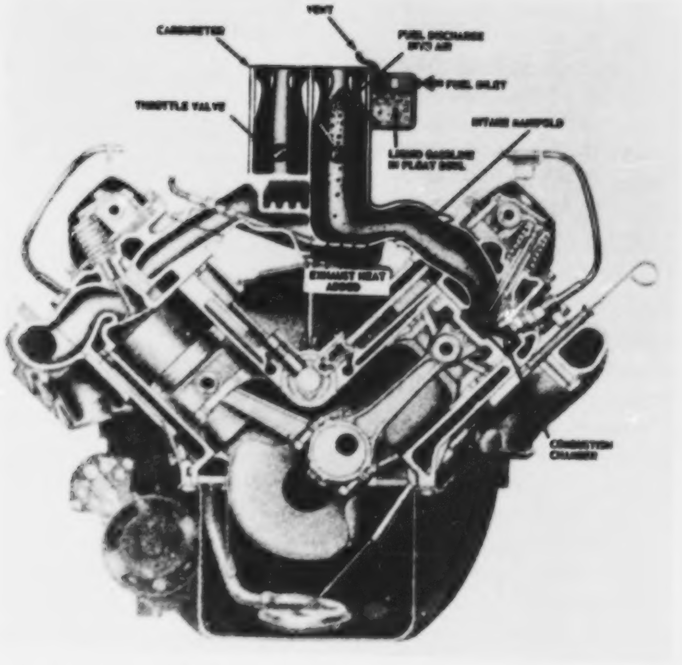

FIGURE 4.—*Induction system of a typical V-8 automobile engine.*

buretor mixture ratio, but it can readily double the carbon monoxide in the exhaust.[6]

There is presently under construction about 60 miles west of Denver, under the Loveland Pass, a tunnel a mile-and-a-half long, at the 11,000 foot or two-mile altitude. All the cars that go through this tunnel will be running about 14 percent richer than they do at Detroit, and they will be emitting at least twice as much carbon monoxide as in Detroit. Much of the Rocky Mountain area, extending all the way from the Canadian border to Mexico, lies at an altitude of nearly a mile. Carburetor jets are sometimes changed in this area but this is a very inadequate solution to this problem.

Although means for accomplishing altitude or pressure compensation are known and have been practiced for many years on piston-aircraft engines, the engineering challenge is to accomplish it for land vehicle use with reasonable increase in complexity and cost, and with reliability.

Another defect of present carburetors is unsteady flow of fuel into the airstream, and imperfect mixing. This can result in a lack of constant mixture ratios to a given cylinder on successive engine cycles. The problem is especially prevalent at low cruising speeds. This condition is improved if the carburetor primary venturis are made small, to provide high suction and good atomization. The development of improved multiventuri carburetors which provide high suction and steady fuel flow under part-load conditions, and which meet all other metering requirements, is needed.

It was mentioned earlier, and Figure 3 reveals, that at full throttle, carburetors are designed to provide about 20 percent more fuel than there is available air to burn. This added fuel at full throttle is provided by means of an enrichment valve in the carburetor, and permits the engine to deliver about 10 percent more horsepower than the best economy mixture. The use of this rich mixture (air/fuel ratio=12/1) causes a great deal of additional carbon monoxide and unburned hydrocarbons, but also reduces the oxides of nitrogen. As efforts to control air pollution are intensified, engines must be designed to operate satisfactorily without enrichment at full throttle, and the public should develop driving habits which do not necessitate this high-emission condition.

Still another source of unburned hydrocarbons is evaporation from the carburetor float bowl and the fuel tank. Again, solutions are known but the real engineering problem is to reduce these emissions without undue cost, and with the necessary reliability.

With the new emphasis on reduction of exhaust emissions, these and other long-standing defects can and must be overcome.

Intake Manifolds. Throughout more than a half-century of multicylinder automobile engine history, the intake manifold has been designed largely on a trial-and-error basis, and has not yielded to analytical methods. The trouble arises from the wet mixture of air and fuel which must be distributed to each cylinder.

If some cylinders receive less fuel and therefore a leaner mixture than others, the overall mixture delivered by the carburetor must be enriched so that the leanest cylinder will not misfire. The potential for increasing the ability of the engine to run on leaner mixtures is quite large. The high-production six-cylinder engine tested with the standard carburetor showed variations of five air/fuel ratios.[7] These variations were almost completely eliminated by a vaporizing system, and permitted the standard engine to run as much as four air/fuel ratios leaner. This ability to run with leaner mixtures should make possible carburetor settings with mixture ratios of 16/1 to 18/1 without engine misfiring and with most emissions at a minimum.

Heating the inlet air, the use of smaller intake manifold pipes, and other factors, reduce maximum power and performance. Unfortunately, the criterion of maximum horsepower has been unduly emphasized in the past, and other characteristics, including fuel economy and exhaust emissions, have been compromised. With the new emphasis on exhaust emission reduction, much more attention is now being given to part-throttle conditions and economy, and this will also result in reduced emissions. I believe it will also be necessary for the public to accept some performance reduction in the interest of reduced exhaust emissions, and the public must be educated to accept this.

One approach to this intake manifold problem is the use of two intake manifold pipes from a multibarrel carburetor to each cylinder intake port.[8] This permits the use of a small pipe with much heating of the inlet mixture for lower-power conditions, and the use of a large intake manifold pipe to each cylinder, with little heating, for the high-power conditions. This system is also well adapted to the use of a staged, or four-barrel, carburetor. This permits the use of small primary venturis with high velocities for accurate metering and good fuel atomization for low-power operation, and large secondary venturi air passages and unheated manifold pipes for maximum power.

Fuel Injection. This term applied to gasoline engines refers to one of several systems used to meter and distribute the fuel to the individual cylinders.[9] In most automotive applications, the fuel is supplied to the air in the intake port just ahead of the engine valve. The chief merit of a gasoline injection system is its elimination of the many difficulties resulting from the presence of gasoline in liquid form in the intake manifold of the carburetor engine, as discussed earlier.

Gasoline injection systems bring many metering difficulties and prove to be very expensive in comparison with a carburetor. In spite of much effort, no gasoline injection system has been able to invade the high-production automobile market. Looking ahead, gasoline injection is a sound approach to precise metering and potential exhaust emission reduction, and is worthy of research effort.

These are only a few examples of potential improvements in induction systems that can in the future accomplish reductions in the exhaust emissions.

In 1962, I stated: [10] "Mixture enrichment has been the necessary and all-too-easy way out of the defects of the complete induction system of the carburetted engine. Enrichment simply and effectively covers up many of the problems resulting from metering deficiencies, incomplete fuel vaporization, poor distribution, and transient conditions."

Unfortunately, the gasoline engine designer has until now never had the incentive to make such a detailed study of the fluid-flow phenomena in the induction system and the flow patterns in the combustion chamber as his counterpart for the diesel engine has found necessary. The emissions problem has changed all this and, under the new incentives, I am sure much will be accomplished.

Combustion Chambers. The combustion chambers constitute spaces above the pistons where the fuel/air mixture is burned. The metal chamber walls are relatively cool in comparison with the burning charge. Therefore, when the flame approaches the wall, the flame is extinguished by cooling, leaving a paper-thin layer of unburned fuel next to the wall. This phenomenon is referred to as wall quenching. For an engine in good condition, wall quenching is the cause of an important amount of the unburned fuel in the exhaust under the cruising condition. Research work is under way to learn more about the details of the quenching phenomenon and to evaluate the factors which influence it. To minimize wall quenching the chamber should be compact, with as little wall surface as possible. Fewer large cylinders are better than a greater number of small cylinders from the standpoint of wall quenching, because larger combustion chambers have less surface per unit of volume.

Cylinders and pistons must also be carefully designed to minimize the amount of charge in confined spaces, where the charge will be quenched (not burned). An example of this is the thin space above the top piston ring and between the piston and the cylinder wall. This calls for very careful design and development. In the past, the criteria of maximum engine output and minimum fuel-octane requirements were most important. Today, chambers are being carefully evaluated with the added criterion of minimum emissions, and marked improvements are being made.

Combustion chamber deposits are also an important factor which influences the amount of fuel left unburned at the chamber walls. It is believed that this is mainly due to the fuel being forced into the porous deposits during the compression stroke, thus evading combustion, and then being ejected during the expansion stroke. The use of fuel and oil with additives which minimize the formation of deposits has therefore taken on new importance.

Tetraethyl lead has been used in motor fuels for about 40 years as an economical means for improving the antiknock quality or octane number of gasoline. This in turn has permitted the use of higher engine compression ratios and greater fuel economy. In 1959, the maximum amount permitted was increased from 3 to 4 cubic centimeters per gallon. In 1958, 455 million pounds of tetraethyl lead were used in motor gasolines.

Recently, its use as an octane improver has been questioned because of its possible toxic effects in the atmosphere. Much additional observation and research are necessary concerning the effects of lead in the atmosphere upon human life, as well as further studies of the effect of leaded fuels upon deposits and exhaust emissions. The gradual elimination of lead from motor gasoline would necessitate major changes in refining techniques and various estimates have been given concerning the increase in cost of gasoline, if the present octane numbers were maintained. These estimates vary from one to five cents per gallon.

Many other factors, including ignition timing and valve timing, have an important influence on exhaust emissions and are being carefully studied. It is to be expected that, with further study of all these factors, reductions in emissions will result. However, it is too early to predict what minimum values of emissions will be attained by means of design improvements within the engine.

REDUCTION OF EMISSIONS, EXHAUST SYSTEMS DEVICES

When all practical future steps have been taken to reduce the emissions from automotive engines, the next step may be the installation of a device on the exhaust system to further reduce these constituents.

This might be an improved version of those already in use in California. Two types of devices appear to have merits, the direct flame afterburner [11, 12] and the catalytic converter.[13] Both have as their objective the oxidation of CO and unburned fuel.

Unfortunately, these devices, like the engine improvements mentioned earlier, do not reduce the oxides of nitrogen. Removal of the oxides of nitrogen is a quite different task from that of oxidizing carbon monoxide and unburned fuel. Perhaps ultimately a device will be developed for use on the exhaust system which will be able to remove not only the small amount of remaining carbon monoxide and unburned fuel, but the oxides of nitrogen as well.

STRATIFIED CHARGE, SPARK-IGNITED ENGINE

There has been much discussion in the technical literature over many years concerning the possibilities of the stratified-charge engine as a means for reducing the exhaust emisions of automotive engines.[14] The principal hopes for this system also include improved fuel economy at part load, due in part to the elimination of intake throttling, and to reduction of the maximum cycle temperature. Of particular interest here is the claim that the exhaust emissions are low because the fuel burns with more excess air.

The concept involves the use of a near-chemically-correct mixture at the spark plug for easy ignition, and a very lean mixture in the portion of the combustion chamber most remote from the spark plug. Much development has been done to obtain the progressively leaner mixture across the chamber, including two-compartment chambers, and controlled air motion with fuel injection into the combustion chamber.

In general, any fuel-and-air mixture requires some minimum amount of fuel to support a flame front, or the flame will be extinguished. The difficulty with all of the stratified-engine concepts lies in the fact that the flame front must progress from the spark plug location into a very lean mixture. If the most remote and lean parts of the charge, or isolated pockets of charge, do not burn, the unburned fuel in the exhaust can be much greater than for conventional engines using a homogeneous charge.

The first stratified and spark-ignited engine was demonstrated by Ricardo, who stated in 1922:[15] "The worst feature about it (the stratified charge engine) is that, if not just right, it may be very wrong; a very small change in form or dimension may upset the whole system . . ." All engineers who have tried to develop a stratified charge and spark-ignited engine can attest to the truth of Ricardo's statements made 45 years ago. No production use has yet been made of the stratified and spark-ignited concept.

The engine has severe requirements for sparkplugs and for the fuel injection equipment. Few data have been revealed to indicate that the exhaust emissions of the engine are superior to those of conventional engines. This engine type is not likely to achieve high production use for automobiles for at least a decade, and it may never do so.

THE DIESEL

The diesel, or compression-ignition, engine is now the main powerplant throughout the world for heavy truck and industrial use. Its predominance in this field is based on excellent fuel economy, reliability, and long life. Its present predominance in heavy trucks was also aided in the past by a tax differential between diesel fuel and gasoline.

The diesel, however, has bad manners; it is noisy, it smokes, and it stinks. These problems are all related to its means of ignition and burning of the fuel. Following the beginning of injection of the fuel into the highly compressed hot air, a short time delay of a few thousandths of a second elapses before burning begins. During this time, fuel continues to be injected into the air charge. At the end of the delay period, there is extremely rapid and uncontrolled combustion of the accumulated fuel, and a corresponding very rapid rate of pressure rise, which causes the sharp metallic combustion noise so characteristic of the diesel. For small engines which operate at higher crankshaft speeds, the effects of this delay are more pronounced, since the crankshaft turns through more degrees during the ignition delay period, and more fuel is accumulated in the cylinder. Much progress has been made toward overcoming this problem of combustion noise in the diesel, involving different concepts of injection and means for fuel vaporization, but complete solution is not yet in sight.

Supercharging of Diesel Engines. The use of engine inlet air pressure greater than atmospheric is now standard practice in large stationary and marine engine diesel practice, and is common for trucks. It is clearly indicated that supercharging as a means to increase power outputs will become much more prevalent.

Although unsupercharged gasoline engines are capable of higher specific outputs than corresponding diesel engines, in the trend to higher outputs the diesel has a clear advantage over spark-ignited engines, because the problems of ignition and combustion control become less difficult at higher output. The gasoline engine, on the other hand, requires more expensive fuel of increased octane for increased output. There is every indication that the diesel will continue to be improved and will remain the main source of power for industrial and truck use for many years.

The exhaust from diesel engines is low in carbon monoxide because these engines use much excess air, especially at idle and light load. Until now it has been the opinion that the diesel is not a large contributor to photochemical smog. There is, however, growing evidence that the unburned hydrocarbons emitted by the diesel are more active in the formation of smog than those from the gasoline engine. Much more research is necessary on the problem of the relative reactivity of the different hydrocarbons, and there is great need for better instrumentation to permit measurement of the various molecular forms in the exhaust. A comparison of these emissions from different types of engines burning different fuels is now almost impossible.

There is presently much activity in connection with the use of additives for diesel fuel to control smoke. These additives consist mainly of a metallic constituent, usually barium. The Public Health Service is concerned about the toxicity of the several forms of barium from the engine exhaust. The smoke reduction accomplished by these additives is quite dramatic, and is believed to be due to catalytic influence on the combustion of carbon. Such additives are presently in use in Europe and are being promoted for use in the United States.

However, present technology is quite adequate to greatly reduce smoke without waiting for fuel additives or other new technology. Diesel smoke usually results from:

1. Use of a fuel with too high specific gravity, because these are less expensive and have higher energy content per gallon;
2. Injecting too much fuel into the engine cylinders in an effort to obtain more power; or
3. Dirty fuel injectors or other poor maintenance.

It is presently economical to operate diesels with a smoking exhaust and this will continue until laws make it uneconomic. I believe that only California is enforcing a smoke limit on diesel operators. Regulation of this highway nuisance throughout the United States is long overdue. Improved instrumentation for measuring the smoke density of vehicle exhaust would greatly aid regulation.

GAS TURBINE ENGINES

The gas turbine engine is old in principle and, following World War II, became the dominant source of power for aircraft. Its use for land vehicles involves much smaller engines, more operation at part load, and the need for a high gear reduction to the wheels. In this application it cannot yet compete in the market place with piston engines.

The development of turbine-powered vehicles has been diligently pursued by the U.S. automobile industry for many years.[16] For automotive use, further reduction in fuel consumption must be accomplished, especially at part load. Marketing a gas-turbine passenger automobile is difficult because a large capital investment must be made to establish high production, which is essential to gain a near-competitive price, and it is unknown how many potential customers are willing to pay a premium price for a turbine-powered automobile.

In contrast with piston engines, the turbine suffers because metals must be continuously subjected to the maximum temperature of the cycle. This makes necessary the use of much excess air to limit the hot-gas temperature. It is to be expected that important developments will occur to permit increased maximum cycle temperature, either through improved metallurgy or turbine blade cooling arrangements. Another deterrent to gas turbines for automotive use is the need for, and the very high cost of, regenerators or heat-exchanger equipment. If means are found to raise the maximum temperature of the cycle another few hundred degrees, and also reduce the engine cost, the turbine engine will become competitive for automotive use.

The gas turbine uses much excess air, and the exhaust emissions are low. Although direct comparisons are difficult to make, the tests of Turunen[17] indicate that the emission of unburned hydrocarbons and carbon monoxide from a turbine-engine-powered vehicle are about one-tenth that from a piston-engine vehicle which has a low California test, on the basis of emissions per pound of fuel burned. The comparison of oxides of nitrogen is more difficult, but it appears that the emission rates of oxides of nitrogen (pound/hour) are equal to or slightly higher for the gas turbine engine.

It is likely that as a result of continuing development, important applications of the gas-turbine engine will come first in the truck and industrial engine applications. The need for increased horsepower gives added advantage to the turbine over piston engines.

THE WANKEL OR ROTARY ENGINE

This much-publicized engine is a positive-displacement engine using the same cycle of events as conventional piston engines. Instead of the piston and cylinder used to provide a chamber of varying volume, the Wankel engine employs a triangular-shaped rotor which orbits within a housing. The three sides of the triangular rotor and the housing form three chambers of varying volume, which correspond to the cylinders of a conventional engine. The chambers of this engine are of necessity elongated, and have a large surface/volume ratio. The engine also has difficult sealing problems. The chief merit of the engine for vehicle use lies in the fact that for a given power it can probably be smaller, and offers new opportunities for installation in a vehicle. It may also prove advantageous in some applications where two-stroke-cycle, spark-ignited engines have been predominant, such as outboard marine engines.

Data concerning the exhaust emissions from this type of engine reveal that the unburned hydrocarbons are high. This is probably due to the large surface/volume ratio of the combustion chambers and to the fact that half of the charge leakage, or blowby, goes to the exhaust. Although the future place of this engine in the spectrum of powerplants is not yet established, it does not appear promising as a means to reduce the problems of air pollution from vehicles.

ELECTRIC VEHICLES

Electric vehicles can be powered by storage batteries, by fuel cells, or by direct transmission of electricity (as in a streetcar). This section will consider the problems and outlook for batteries as an energy-storage system. Fuel cells are discussed in the next section.

The battery-electric vehicle must be considered as a system with its necessary stationary electric-generating plant and its electric-distribution equipment. Table I

TABLE I.—*Estimated average efficiency of components of the total battery-electric vehicle systems*

Component	*Efficiency percent*
Central powerplant	40
Electric transmission and transformers	85
Battery charger, conversion of AC power to DC	80
Battery charge-discharge effectiveness	70
Motor and controls	75

The overall efficiency of this energy system is the product of all the component efficiencies, which is 14 percent.

shows typical values, based on current practice, of the near-maximum efficiency of these necessary steps in the chain of power supply to a battery-powered vehicle. Some of these efficiencies can vary widely. For example, the efficiency of the battery charge-discharge cycle is very dependent on the rate of charge and discharge. For shopping-vehicle use it is to be expected that there will be much stop-and-go driving, with intermittent high rates of discharge.

The product of all these component efficiencies is 14 percent which is the overall efficiency from the central powerplant fuel supply to the output shaft of the electric motor. This efficiency can be much less for off-design conditions. For a typical automobile, the overall thermal efficiency of its gasoline engine varies at steady speed in high gear from approximately 13 percent at 30 miles per hour to 22 percent at 70 miles per hour. It can be seen that the overall thermal efficiencies of the two power systems are of the same order of magnitude. However, these figures represent a comparison of a highly developed gasoline-powered automobile with a less-developed battery-powered system that probably has greater potential for future improvement in some of the efficiencies of Table I.

The low available energy per unit weight of batteries is the major technical block to the use of the battery-electric system for automotive propulsion. This is usually expressed as watt hours of energy available per pound, and is a measure of how far a battery-powered vehicle can travel before requiring a recharge of its batteries. Another almost equally important criterion is the ability to deliver power at a high rate for short periods of time. This can conveniently be expressed as weight/power ratio. Values of these abilities are shown in Table II,[18, 19] for conventional batteries and those that have been mentioned as having future potential advantages for vehicle propulsion. Warning is given, however, that these numbers can be very misleading, since they depend on many factors, and on whether a laboratory or commercial device is being considered.

It will be noted from Table II that silver-zinc batteries show an energy density five times that of our conventional lead-acid batteries. Unfortunately, they are very expensive, partly because of a high silver content. Also, their life as measured in terms of ability to be repeatedly charged and discharged is only about 10 percent of that of a lead-acid battery.

The zinc-air battery has energy density as good as the silver-zinc battery, and is very much less expensive. Unfortunately, this unit is the poorest of those shown from the standpoint of weight per unit of power, and is unacceptable on this basis.

TABLE II.—*Comparison of battery systems*

	Energy density, watt-hrs. per lb. (slow discharge 5 hrs.)	Weight/power ratio, lb. per kilowatt (rapid discharge ¼ hrs.)
Lead-acid	10	20
Nickel-cadmium	14	25
Silver-cadmium	24	15
Silver-zinc	50	4
Zinc-air (General Dynamics)	60	30
Sodium-sulfur (Ford Motor Co.)	150	10
Lithium-chlorine (General Motors Corp)	150	3

Many paths to possible higher output are being considered. The Ford sodium-sulfur unit, said to be in an early stage of development, is one example. This presents serious problems, since sodium is very hazardous if it contacts water, and the unit must be operated at a temperature of 500° F. or higher. The use of hazardous materials such as sodium at elevated temperatures poses serious problems of safety and starting for vehicle use. General Motors has concentrated some of its effort on the lithium-chlorine cell, which operates at a temperature slightly above the melting point of lithium, about 1100° F. This molten material also presents problems of safety and

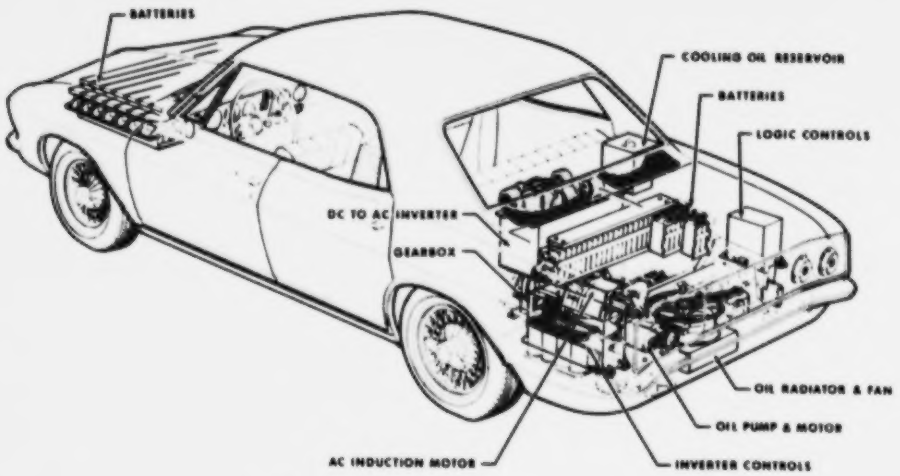

FIGURE 5.—*General Motors battery-powered vehicle.*

startup. No one knows when, if ever, such batteries will be practical for propelling a personal vehicle.

The most advanced state of the art is illustrated by an experimental battery-powered car of General Motors,[19] shown in Figure 5. This is an experimental vehicle developed by General Motors to learn about and demonstrate the possibilities of an electric vehicle. The vehicle uses the basic structure and running gear of the Corvair automobile. It is fitted with a silver zinc battery pack consisting of 286 cells with a total weight of 660 pounds. The car is equipped with a very compact alternating-current 115-horsepower electric motor. A complex set of solid-state devices for converting the direct current from the battery into AC with varying voltage and frequency is provided by the motor control. The car was designed to have performance comparable to that of a standard Corvair, but with a necessarily reduced operating range. The performance is indicated in Table III.

The limited range imposed by the batteries is apparent. On the basis of the estimated cost of these batteries when purchased for a production of 100,000 units, the computed cost to propel the car is approximately $3.00 per mile. This is more than 100 times the cost to propel a conventional automobile, and there is not enough silver for this use. To be successful, much less expensive battery combinations must be developed to a high standard of performance.

TABLE III.—*Performance of battery-powered vehicle*

	Battery-powered Corvair	Corvair with standard power-plant
Weight . . . . . lbs.	3, 400	2, 600
Performance, 0–60 m.p.h . . . . . sec.	16	16
Top speed . . . . . m.p.h.	80	86
Range . . . . . miles.	40–80	250–300
Power-train weight . . . . . lbs.	1, 230	610

Another aspect of the battery-powered vehicle is the exhaust emissions of the total system in comparison with those of a gasoline engine. With the assumption that the central powerplant burned oil and the overall efficiency of the battery- and gasoline engine-powered systems are of near equal efficiency, and neglecting any battery emissions, the battery system would have only a small fraction of the unburned hydrocarbon and carbon monoxide of the gasoline automobile.[20] The oxides of nitrogen would be comparable, and the oxides of sulfur would be much larger, on the basis of present practice for both systems. The central station might also use gaseous fuel, with greatly reduced emissions. The central station and battery-electric vehicle system has the important advantage that the central station could be located outside an area subjected to unusually high pollution, such as Los Angeles. Also, there would be relatively few stations and they would therefore be easier to control.

With the rapid development of central-station atomic power, the emissions due to fossil-fuel combustion would be eliminated, and a further advantage would accrue to the electric vehicle. It may now be projected that most large central station powerplants built after 1980 will be powered by atomic energy. However, it should also be kept in mind that the cost of generating electric power at the powerplant is only about 20 percent of its selling price. There is also a problem of disposal of radioactive waste from atomic powerplants.

If the present basic research relating to a sustained fusion reaction leads to the possibility of abundant power from sea water, there would be a whole new outlook on power sources. At such a time our concern over world energy sources might also be ended. However, this represents a very much longer-range projection.

There is a future place for battery-electric vehicles of small size and short range. Local shopping and short-range commuting are good examples. Applications where as much as half of the fuel is presently consumed while idling, such as some mail and delivery trucks, represent a potential field for electric vehicles. It does not seem likely, however, that battery power will be used for decades for powering conventional-size passenger automobiles in intercity service.

FUEL CELLS

A fuel cell is a device for converting chemical energy directly into electric energy. There is a very interesting discussion of its principles and space applications in a 1964 article in Fortune magazine.[21]

Like most other powerplant systems, the fuel cell is not a recent conception. Sir William Grove of England, about 1840, demonstrated that hydrogen and oxygen could be combined with the aid of catalytic platinum electrodes to produce water and a small electric current. For generations, only a modest and intermittent effort has been expended to produce electricity directly from fuels by these methods of electrochemistry. However, this has now been changed dramatically by the requirements of the space program, and intensive research by many groups is in progress. Some of the results of this effort are represented by the General Electric fuel cell powerplant system used in the Gemini 5 and 7 space flights. This system, consisting of many thin fuel cells, liquid hydrogen and oxygen storage tanks, coolant pumps, and preheaters to vaporize the hydrogen and oxygen, weighed 400 pounds, and was capable of delivering one kilowatt. During the fourteen-day flight of the Gemini 7, this powerplant delivered about 200 kilowatt-hours of energy. For this application the fuel cell has many advantages, including the use of the same fuel and oxidant as the main propulsion engines; and its waste product, or exhaust, is drinking water.

An important aspect of this power system for space applications has been the very large research effort that has been triggered. Most of the major companies involved in this effort, including General Electric, Pratt and Whitney, and Union Carbide, are all looking to commercial applications. Before there can be much commercial application of fuel cells their cost must be greatly reduced; the platinum in the Gemini 1-kilowatt (1⅓ H.P.) unit is estimated to cost $7,500. Coming back to our earlier premise that an automotive portable powerplant must use a relatively cheap and easily-handled fuel, it is almost essential that a fuel cell for land-vehicle propulsion use a petroleum-base fuel and take its oxygen directly from the air.[22] Another approach is to reform the fuel before supplying it to the fuel cell, but such processes also add to the complexity and reduce the overall efficiency of such systems. Further, all fuel-cell systems which burn conventional fuels and air are quite certain to have some products of in-

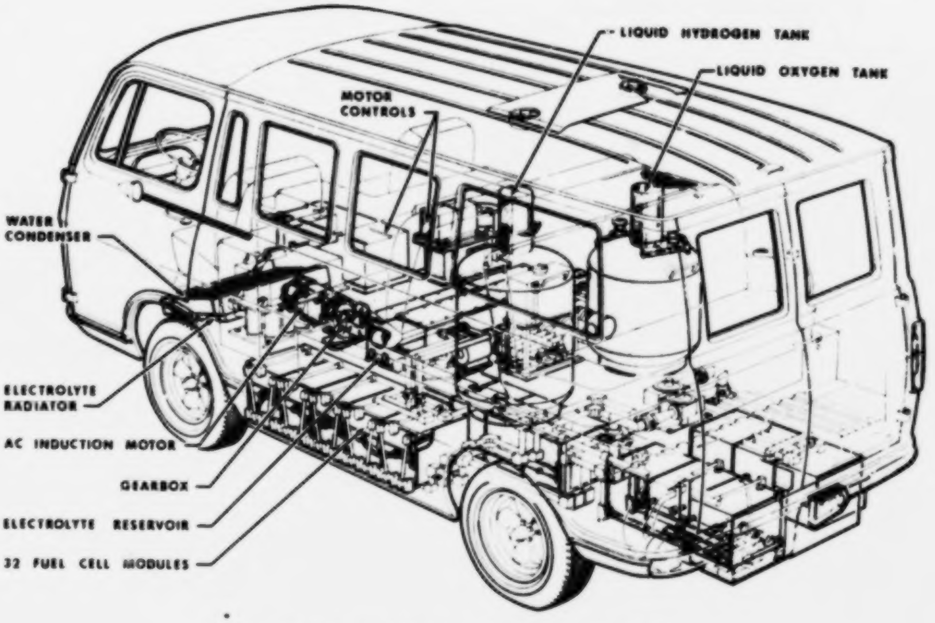

FIGURE 6.—*General Motors fuel cell-powered vehicle.*

complete combustion, and undesirable emissions.

General Motors has also developed an automotive vehicle to study the problems and possibilities of fuel cells as a means of vehicle propulsion, as outlined in a news release.[19] This program was carried out with the cooperation of the Union Carbide Company, which supplied the fuel cells. Figure 6 shows a view of the vehicle, and indicates the principle components of the propulsion system. Some of the principal characteristics and performance features of this vehicle, in comparison with the same vehicle with a conventional gasoline engine system, are shown in Table IV.

The electric control system and propulsion motor for the fuel-cell-powered Electrovan were essentially the same types of equipment as used in the battery-powered vehicle. The liquid hydrogen and oxygen were kept in vented cryogenic insulated tanks at their very low boiling points of −423° F and −297° F, respectively; so some of the liquids are continuously lost by boiling away.

Figure 6 reveals that the fuel-cell vehicle was nearly filled with the necessary propulsion equipment and Table IV indicates that the range of operation was quite low, and that the power-train weight was excessive. Obviously, much remains to be done to make the fuel cell a practical vehicle propulsion system. Again, a highly developed engine-transmission system is being compared with a fuel-cell system in an early stage of development.

TABLE IV

	Fuel cell-powered vehicle, the Electrovan	Conventional GMC van
Weight . . . . lbs.	7,100	3,259
Performance, 0–60 m.p.h . . . . . . sec.	30	23
Top speed . . . . . m.p.h.	70	71
Range . . . . miles.	100–150	200–250
Power-train weight lbs.	3,650	870

The major problems of fuel cells involve processes of catalysis and catalytic materials. Catalytic processes are extremely complex and remain mysterious. In this fact lies hope that future development may lead to remarkable improvements in performance and reduction in cost. For this reason, fuel cells may represent a much better long-range hope than storage batteries as a means for vehicle propulsion. One should also not overlook the possibility of breakthroughs in technology in this relatively new field. The same is true for all fields of power development, but the chances for this are much less in well-developed systems.

Perhaps the best opinion that can be expressed here is that of Dr. Arthur M. Bueche of the General Electric Company, which developed the Gemini fuel-cell powerplant system. In testimony before a U.S. House of Representatives Committee last summer, he stated:[23] "When will we have fuel-cell automobiles? I don't know. I don't know *when*, and I'm not really sure *if*. All I can say is: On the basis of what we know now, fuel cells *might* someday be very attractive for vehicles because they *might* not give off any appreciable noxious exhaust, and they *might* be developed to fit into more compact portable packages, and they *might* be made inexpensively enough for general use in vehicles.

"That's a mighty long list of 'mights.' But fuel-cell research has great momentum. The need for alleviating pollution from vehicles is very great. The accomplishments of man, when he puts his mind to it, are being dramatically demonstrated in today's world.

"In conclusion, we must seek to advance with research and development on all types of vehicle propulsion systems that offer hope for reduced emissions, including conventional and unconventional types. In the meantime, we must also be aware that any successful program for reduction of emissions must include an effective vehicle and powerplant inspection and maintenance program."

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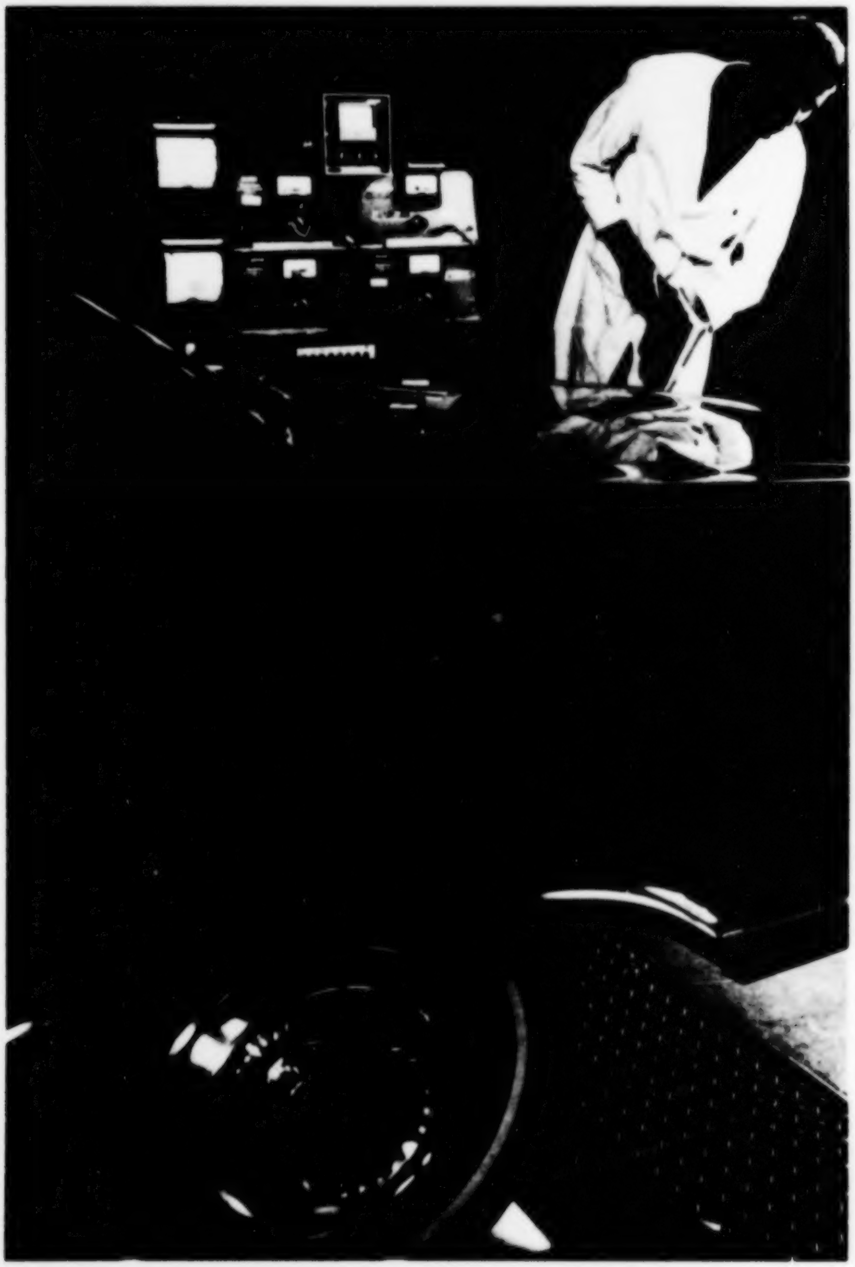
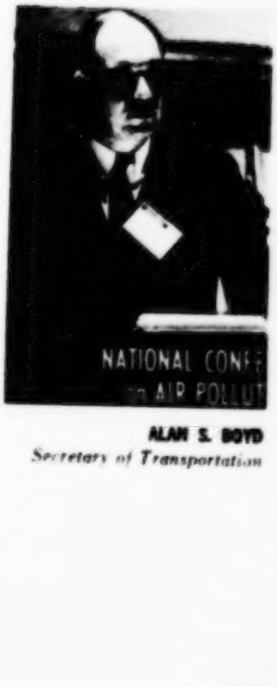


MASS TRANSPORTATION IN THE CITY OF THE FUTURE



ALAN S. BOYD
Secretary of Transportation

The Public Health Service is to be congratulated for its timely initiative on the problems of air pollution control. The diversity of interests represented at this conference suggests that the historic moment has at last arrived when the job of decontaminating our atmosphere is to be taken seriously. The Department of Commerce will continue to give the fullest support to this program.

I have followed these discussions on air pollution with a growing sense of urgency. There is obviously much work to be done by us all without delay. Basically, we are confronted by a technical challenge, a lethal side-effect to be mastered by our scientists, engineers and industrial technicians. Realistically, however, none of these experts can hope to prevail until the political engine gets up a head of steam.

Since I cannot shed any professional light on this subject, I assume that my role here is to add a little heat. If the truth be known, we are all here as a result of progress, for as Chesterton reminds us, "Progress is the mother of problems."

In considering the very serious problem at hand, I think we should have the grace to acknowledge one essential fact. Air pollution arises from something which all of us, at least in the past, had counted as a blessing. I refer to the general prosperity of the nation, to its advanced technology, to the increasing health and size of our families, to social mobility which permits most of our citizens to live wherever they can afford to. And certainly not less in importance, I refer to our freedom of personal choice in the marketplace.

Withdraw just a few of these circumstances; and it is quite possible that American cities would not be suffering from the particular blight that concerns us today.

Air pollution is a subject that presses the emotional button almost like the public abhorrence of chemical warfare. It would, I believe, be most unfortunate if the highest standards of objective inquiry were not maintained between the principal parties in this vital domestic dialogue.

Now that natural forces have helped to dramatize the air pollution peril on a larger-than-regional scale, and citizens are aroused on the East as well as on the West Coast, there is need for high health standards and for safety margins that can absorb meteorological vagaries. Our society should also be exceedingly careful about the new restraints and responsibilities, the added economic burdens which it imposes on industry.

Smokestacks and tailpipes, in a figurative sense, have only very recently discovered that they were serious malefactors. For a very long time before, they were hailed as society's benefactors. There's quite an adjustment to be made. Let it be made in an orderly way.

Some of our industrial progress, it now appears, is illusory; as a result, some of the profits of industry have also become illusory. The gains achieved at the expense of the community's health and safety proved not to be gains at all, and the profits arising from such dubious advances must now be spent on remedies in the public interest.

This is industry's inescapable obligation.

But while insisting that the smokestack and the tailpipe assume their full social responsibility, the community at large should also be aware that its way of life may be changed very dramatically if it demands the unreasonable or the impossible.

We should never forget that some of the cleanest air in the United States is found above ghost towns.

At every stage of the decontamination program, we ought to be weighing the economic consequences alongside the health implications. Air pollution, beyond a certain level, is injurious to the family, but so in its own way, is unemployment. Our problem in some industries, in some localities, is to find an acceptable balance to eliminate obnoxious side effects while holding on to the jobs that support a community. Over the long run, punitive legislation and scare tactics will not produce the desired result. I personally feel that the experts in air pollution need to be positive and much more educational in their approach. They have an obligation to present the issue in terms that will advance our total civilization rather than inhibit progress. For example, common sense tells us that air pollution of the manmade variety is mainly produced by the liberation of energy, the inefficient or incomplete release of energy. Naturally, the largest amounts of energy are being released in and around our great cities.

The imposition of controls to reduce contamination of city air is a negative goal. It may be the only measure we are able to implement at this time, but it certainly is not the best long-range approach. The positive goal that I would wish to see emphasized is the need for far more efficient harnessing of the energy sources which are actually or potentially at our disposal. In that process, we should, of course, insist on minimizing by-products of the type under discussion in this and other panels of the present conference.

The relative efficiency of engines and heat and powerplants in industrial and home use is obviously not my specialty. I am, however, aware that the processing and combustion of fossil fuels are the principal sources of air pollution in the cities. I am also aware that the industry with which I am intimately concerned, the transportation industry, moves on fossil fuels. Let me dwell for just a moment on the implications. We all know that the internal combustion engine is a great air polluter and a great waster of energy. So I raise this public policy question: should the Nation's ingenuity and resources go primarily towards the muzzling of automobiles, or should they be focused on research and development for a more efficient engine? Either way, the cost will be enormous.

A report just issued by President Johnson's Interdepartmental Energy Study Group suggests that air pollution control will cost each owner of a conventional automobile about 7 cents per gallon of gasoline. Projecting this on the basis of annual fuel consumption for the average passenger car, the figure is approximately $46 per car per year. In other words, for the nation as a whole, the cost of an 80 percent effective exhaust hydrocarbon control, for private automobiles alone, may well be upwards of 3½ billion dollars annually.

Within the transportation sector, as you know, there are a lot of other things besides the family car. What the added cost of air pollution control would be for the Nation's trucks, buses, boats, locomotives, and aircraft, no one is yet in a position to estimate. As a very conservative guess, I believe these added costs could be equal to those of all the family cars combined. If this is the case, then the price tag for comprehensive air pollution control of the transportation industry may be about $7 billion annually. That would be about $2 billion more than the present yearly budget of our space program.

If we can contemplate an expenditure of that magnitude to control just a portion of the contamination of our atmosphere, I think we should consider some of the alternatives to control.

Probably if we were willing to invest the entire $7 billion a year in transport research we would shortly find a way to nullify gravity itself, or even achieve some form of teleportation. With a fraction of that sum, your Government might well collaborate with private industry in the development of a small propulsion unit, to meet the new set of specifications imposed by the densities of urban life. Whether that would be an electric or a plasma engine, or even an amazingly improved internal combustion system, is a matter of speculation. But given the specifications and the political and economic necessity, I have confidence in America's transportation industry, its suppliers, its manufacturers, and its ability to provide what is needed. In the interim, let us not become so determined on our ends that we grow indiscriminate in our means.

I have in mind such double-edged measures as restricting automobile access to the central business district. This two-in-one solution to both the pollution problem and the traffic congestion problem has been seriously proposed by people who feel very deeply concerned about the future of the central city. They reason that most drivers are captives to their jobs in the heart of town and that, whether they like it or not, the suburbanites are obliged to commute via public transit. Personally I would like to see this idea tried out, so that we might have a real-life experiment and develop some data from which we could draw some general conclusions. Unfortunately, however, most discussions about urban mass transportation seem to get along without facts in the same way that anaerobic amebae are able to live without oxygen.

The fact is that, in national terms, urban transit is a declining industry. It is declining absolutely in cities of under 500,000 population. It is declining relatively in larger cities. Urban mass transit represents a gross investment of approximately $4¼ billion. It would be a tragedy to see that investment dwindle and go down the drain. Great as the economic loss might be, the social loss would be incalculable. And yet ironically, I feel that many American cities, large and small, are helping to destroy transit, by the way in which they habitually think of transit. They are helping to foreclose its future by assigning to it unreasonable, if not impossible, tasks.

Above all, each of our cities must first decide what urban mass transit really means to that community. Shall we look upon transit as a profit enterprise? Shall we look upon transit as an instrument for equal opportunity? Shall we regard it as a service to commerce and industry? In other words, shall we consider it a necessary part of the cost of doing business? Or again, should we perhaps view transit as one of the fixed costs of living in a city?

The cities of America have to decide this question. It is not an abstract philosophical question. For the answer has a direct bearing on decisions as to who shall pay for this service and in what way. If, for example, a community should decide that public transit is a cost of doing business, then perhaps public transit should be free, as the elevators in buildings are free. In this case, the expenses might be met by an annual levy on nonresidential real estate.

Or, to follow this line of thought a little further, let us say that a community decides that it wants public transit to serve as a social equalizer. As a simple illustration, the Watts area of Los Angeles, I'm told, has very poor public transportation to the major employment areas of that city. Some researchers found that the one-way trip from home to job in those areas would usually take one-and-a-half hours via a succession of buses. According to this study, which was published in *Christianity and Crisis*, unless a person had a car, there was physically no way to get from Watts to one of the major employment areas by the start of the workday. Now, for the sake of argument, let us say that the white inhabitants of Los Angeles were willing to subsidize the population of Watts. They might in such a case provide express bus routes at below-cost fares, or free, as a means of social equalization.

Allow me to say that this view of urban transit as a social equalizer is by no means irrelevant to the future of cities. As you know, Negroes now comprise the backbone of the slums in most of America's central cities. One marketing consultant estimates that by 1970, Negroes will represent close to 50 percent of the population of such cities as Baltimore, Detroit, New Orleans and St. Louis. Meanwhile, more and more industry has been moving to the outer edges and suburbs of the city. How will the people of the central city get to their jobs?

If problems such as this one must be dealt with by transit people after the fact, then I believe that transit is indeed being destroyed by a habit of thought. One urgent necessity is to begin thinking about urban mass transportation in such a way as to make a difference in the eventual outcome.

It would be folly to create the new and wonderful urban transit facilities that are within our technical capability if in the end people choose not to live or work in central cities. We have to get to the soul of this subject. We have to find out what people really want, and what people will really use, and what people are really willing to invest in with their tax dollars.

In the future I suspect urban travel consumption patterns will vary a great deal more than they now do from city to city. I say this very hopefully out of deep respect for the individuality of most large cities, which I would like to see not only preserved, but also reflected in the transportation policy decisions made by those cities.

Consider the variety. There are cities dominated by a single industry, like Detroit. There are cities with very diversified industries, like Chicago. There are ocean port cities, like New York. There are governmental cities, like St. Paul and Albany. There are health, retirement, and recreation centers, like Miami. There are religious communities, like Salt Lake City, and so on. These special characteristics will not disappear in 20 or 30 years and no single transportation scheme will fit all of them. The more I examine mass transportation problems, the more convinced I become that there are no standardized solutions.

A city adapted to landscape limitations, as Pittsburgh is, for example, may continue to use existing trolleys for decades, simply because the town is built in valleys favoring radial residential patterns. San Francisco may continue to use cable cars into the indefinite future because they work on steep hills and they have a high sentimental value. New York may stand pat on its subways because you might as well think of Manhattan as one colossal building and the subways as a major "elevator system," running horizontally.

Then, let us think of the new cities that are yet to be built in this country. These could be planted in the wide open plains and grow to half-a-million population in ten years if some new economic basis were to be discovered. Or they could be the new totally planned communities that are now being put into orbit around central cities. Or they could be partially below-ground cities, around major airports such as Dulles. Obviously, when you build a community from scratch, there are opportunities to create new transportation patterns, such as pedestrian towns for compact, self-contained skyscraper cities.

I think it is likely that the new satellite towns of the future will adopt many different strategies to minimize the congestion problems of commuters. I wish them all well and I think they should always be able to come to the appropriate Federal agency for technical assistance and planning grants and loans. I only hope that when this happens, we in the bureaucracy will have the valor to encourage these new approaches.

Abstractly, the basic reality of transportation is that it is a derived function and the basic fact of an urban environment is that it is a calculus of rapidly changing relationships. When you combine the two formulas you discover that urban transportation is affected by more factors than it can ever hope to influence. A zoning decision, for example, in a small satellite town may do more to alter the pattern of metropolitan travel than a multimillion dollar investment in new transit equipment.

A slight adjustment in U.S. farm policy can drastically alter the characteristics of a city's labor pool, along with its transportation requirements. The adoption of a local payroll tax, or a sizable reduction in property assessment, might in a short time change the volume and direction of rush hour traffic.

It seems to me that antibiotics and racial prejudice and FHA loans and birth control pills can make as tangible a contribution to urban mass transportation as geography, technology, or eminent domain. That contribution may be largely unpredictable and uncontrollable, but not entirely so. It poses an immensely complicated problem, demanding not intelligence alone, but patience as well and subtlety and flexibility, qualities that are not always joined with entrepreneurial skill and civic patriotism.

Yet any city's long-range transportation planning which ignores these social factors, or gives them insufficient weight will be at their mercy.

I have a strong feeling that we are all, to some extent, prisoners of our own rhetoric in this matter. I think of Cicero's remark, "He who is ignorant of what happened before his birth is always a child." That practical Roman was alluding to the state of anxiety and ineffectiveness of people who are required to make choices from an unfamiliar set of alternatives. His remark refers to people who are unacquainted with man's previous experience in analogous situations and who have no knowledge of responses made earlier to similar questions, or of what resulted.

If any lesson should have been learned about urban transportation in the past 75 years, it is the need for systems to have the greatest possible flexibility. Yet some are proposing to install rail rapid transit, which is the least flexible of all systems, in all cities, including cities which obviously lack the densities required to make rail traffic economically feasible, without regard to any of the other qualifications. And often, the proposed route is over an abandoned railroad right-of-way, as though the abandonment had no significance whatsoever.

I think many of you must share my feeling of quizzical annoyance at the way in which many discussions on urban mass transit are framed. We are asked to pretend that all of our mobility problems are newly acquired and without precedent. This really isn't so.

For example, in 1902, which was a decade before the automobile came into general use, Chicago hired an engineering consultant "to devise some method of operation which will relieve the congestion of the overcrowded thoroughfares in the central portion or business district of the city." And that expert advised that nothing could be accomplished unless team-traffic were stringently regulated.

In the City of New York, in 1903, the Merchants' Associaton was bemoaning the transportation crisis in Manhattan. It blamed the congestion on the horse and buggy. It denounced carriages standing at curbs, trucks delivering to the fronts of buildings, street repair during the daytime, crosstown traffic, and teamsters in general. These merchants predicted there would never be a time under the most ideal circumstances when streetcars could move past a given point on Broadway faster than an average speed of eight miles per hour during rush hours. How right they were.

There is a long history to the complaint that congestion is killing the core city, a history that did not originally have much to do with the automobile.

Today some of the civic cores have indeed atrophied, almost to the point of no return. I am not at all sure that congestion was the primary cause, and I am not at all sure that if congestion could be arrested the process of decay in those areas would be reversed.

History seems to illustrate one universal feature of cities: they always arise at transportation termination points. In a sense then, the cities' growth has been a capitalization of transportation delay. It can even be argued that transportation congestion is actually the health of cities. For example, in a crowded department store, you can always find a certain number of customers dissatisfied with the service. But a crowded store has no worries about going out of business. On the other hand, a store that asphyxiated its customers would indeed have a doubtful future.

A CONGRESSIONAL VIEW OF THE PROBLEM

BIRCH BAYH
U.S. Senator from Indiana

I am honored to have the opportunity to address such a distinguished group of experts on the serious problem of air pollution. With us today are people who have dedicated many years of their lives to study and activity in this extremely difficult and important field, and I must admit that, as I face you, I feel something of what Daniel must have felt as he confronted the lions.

I was concerned when Secretary Gardner and I discussed my assigned topic. At first I thought he said I was to give *the* Congressional view of automotive air pollution, and when I thought of representing 534 of my colleagues on this or any other subject, I no longer felt like Daniel. Instead, I felt like Adam, minus a figleaf or two. But the Secretary quickly assured me that my topic was to be *a* Congressional view, so that I had a bit more leeway and could outline my own thoughts.

I suspect that before the early 1960's a Congressional view of the automotive air pollution problem would have differed only slightly from the view held by the general public. Aside from a few large metropolitan areas and scattered technical circles, the urgent need for remedial action had not impressed itself on legislators, and certainly had not impressed itself on the general public. Although environmental pollution impairs the quality of our lives and, in extreme cases, shortens them, we nonetheless lived in an age of ignorance and inaction prior to 1960.

Few realize that, while the invention of the steam engine and the automobile and the rapid growth of heavy industry lifted our nation to heights of affluence, these advances dangerously increased our capacity to contaminate our air. Until relatively recently, polluted air was accepted as the price we had to pay for progress.

We failed to learn from the Meuse Valley tragedy of December 1931, when weather conditions allowed heavy industrial discharge to stagnate in the air. Sixty people died as a direct result. Similar atmospheric conditions occurred in Donora, Pennsylvania in 1948. As a result, some 20 people died and illness developed among about 5,000 others. In London, in 1952, more than 4,000 people died as a result of pollution in the air. Similar occurrences in London and New York City within the past four years have resulted in an estimated 1,200 deaths.

Polluted air has been proved to be a contributing cause or an aggravating factor in a number of respiratory ailments. Studies conducted in 19 States, including my home

State of Indiana, have demonstrated that polluted air can cause severe damage to agricultural crops, something that the average farmer doesn't realize. Air pollutants also produce adverse effects on many common materials. You are all aware of what they are—those of you have labored in this vineyard for so long—metals corrode, fabrics weaken and fade, leather becomes brittle, rubber cracks and loses its elasticity, paint discolors and peels, concrete and building stone discolor and erode, paper stiffens and cracks. I could go on and cite many more specific damages directly attributable to air pollution.

In 1962, the Civil Aeronautics Board cited air pollution—in the form of smoke, haze, sand, and dust—as a contributing factor in 15 to 20 airplane accidents that year. Authoritative estimates place dollar losses from air pollution—and I'm sure you will hear this figure throughout the entire Conference—at approximately $11 or $12 billion per year in the United States.

As a member of the Senate Subcommittee on Air and Water Pollution, I have learned firsthand the terrible price we as a nation have paid for neglecting our responsibility to purify our air. Fortunately, in my judgment, this age of ignorance and inaction, as far as air pollution is concerned, is beginning to come to an end. More positive action regarding pollution abatement has taken place within the last six years than in all of our previous history. But as long as we take advantage of the wonders of science, increase our standard of living, cluster in urban centers, and maintain a growing birth rate, our pollution problems will continue to increase.

As Secretary Boyd points out, all indications are that these trends are going to continue. And as a result traditional methods of waste disposal and power generation will become even more incompatible with the best interests of our health and welfare.

Under the skillful leadership of my colleague, Senator Muskie of Maine, the Senate Subcommittee on Air and Water Pollution has initiated landmark legislation. I refer specifically to the Air Pollution Studies Act of 1962, the Clean Air Act of 1963, and the amendments of 1965 and 1966. Indeed, this legislative activity and the resulting public attention heralded the beginning of a new period or, if you will, a new age, one of unparalleled awareness of air pollution.

Today, environmental pollution is front-page news. We owe a deep debt of gratitude to Senator Muskie for making it front-page news, because we are not going to be able to adopt the programs referred to by Secretary Boyd, which will require significant amounts of tax dollars, unless the public is made aware of the importance of air pollution. I think the public is much more aware now than it has been in the past.

It is particularly important to focus a substantial share of our attention on pollution produced by automotive emissions. Until recently the public was not aware of the importance of automotive pollution. They would look at the diesel smokestack and think that the diesel engine was a much greater contributor to air pollution than the gasoline engine. They didn't realize that the gasoline-powered engine was a significant factor in air pollution.

Currently, we have more than 90 million cars, trucks, and buses on American roads, and emissions from them account for 50 percent of our national air pollution problem. It is tragic, in my judgment, that in no State except California is there a program *currently* in effect to curtail or eliminate these noxious emissions. When it is considered that any place inhabited by 50,000 or more people has enough motor vehicles to create a potential air pollution problem, and that by 1975 we can expect that three-fourths of our 235 million people will be living on about one-tenth of our land, it is obvious that we are on a collision course with disaster.

I remember very well the experience we had when our committee went to Los Angeles. We arrived over a weekend. There had been a rain, and you could look off and see the mountains beautiful in the distance. But by Tuesday you couldn't see the mountains at all. We got into a couple of helicopters to go north of the city to look at some of the industrial contributions to the problem. We were riding at about 1,000 or 1,200 feet and there, 200 or 300 feet below us, was a thick layer of smog. You could just see it there. During the last few weeks, the good Lord brought to the attention of those of us who live on the East Coast the fact that this is no longer a problem solely confined to the people of Los Angeles.

This is the general import of the information that has been presented to the Senate Public Works Committee, beginning in 1963. My view of this problem, which I am sure was shared by most of my colleagues, was that we were facing a crisis. We had to immediately design constructive programs to curb the flow of automotive emissions. We had no choice. Inaction would have resulted in ultimate national disaster.

Serious problems confronted us as to how best to attack this problem. Although the auto industry had been working for many years, few were satisfied with the results or were ready to assure the dependability of pollution control systems. Mindful of these difficulties, but deeply concerned with the possible catastrophic consequences of delay, the Congress in 1965 provided for the establishment of national standards for the control of air pollution for 1968 models of gasoline-powered motor vehicles. Each of us was very much aware that compliance with these standards would add to the cost of the motor vehicle, and I think we would be somewhat naive not to realize that the added cost is significant.

While we are hopeful that the actions of the Congress and the Department of Health, Education, and Welfare will be successful, I remain concerned about several problems which, in my opinion, are not yet receiving the scrutiny they deserve. Most obvious, I suspect, is the problem of stopping pollution from motor vehicles manufactured or imported before and during 1967. Next year there will be more than 100 million such vehicles on the road. The problem is further compounded because many of these cars have a life span of eight to ten years and will thus be polluting our air for some time.

Even if sales and production figures continue at present levels, only 10 percent of the vehicles on the road by the end of 1968 will meet pollution abatement standards. In addition, it is common knowledge that the older the car, the greater the likelihood that it will pollute the air more severely. I think we have enough knowledge now to know that controls can be added in a relatively economical manner when the car is being manufactured, as the block is being attached, as the machine is being mass-produced. But once it's on the road, the cost of adding controls increases severalfold.

Therefore, without technological breakthroughs to permit us to treat old cars, we are not going to make much immediate headway toward curbing automotive pollutants. Although I have no desire to tell the automotive industry how to spend its profits, it would in my judgment, be wise to use a part of them to begin a greater joint effort with government to explore this serious problem. I think the automotive industry has to move more actively in this area. It has made considerable progress, but what has been done so far will not be adequate.

Incidentally, I have been a strong supporter of any tax-incentive scheme which would give industry a tax break for funds which they spend in this direction. I do not confine this to automotive pollution alone, but also include other types of pollution.

Our present air pollution abatement program is, as it must be at this time, heavily oriented toward research and development. Much of the work done is performed at academic levels and is not yet integrated to the extent that it should be and must be. Although this approach has yielded great advances, we must constantly search for new approaches, looking for new ways to make even greater gains.

For example, let us consider the advisability of establishing a goal-oriented research program similar to the one we established to conquer technological hurdles in our space program. When we were thinking about getting into the space program, back in the 1950's, there were only a handful of people who had any idea of how to do the job. We are now a pretty far piece down the road toward conquering this, and the only way we have been able to do it is to harness the expertise, the research and technological capability of our great industrial complex.

Let us identify our most crucial abatement needs—not just in the area of autos—define to the best of our ability the type of technical breakthrough needed, and present the problem to the American business and technical community. Research and development funds could be awarded to those firms presenting the best tentative plans for solving a specific problem. Concentrated work would then begin in a specific area of concern. I am aware that some of this is being done now, but I think we need to do more of it, and I, for one, think that one reason why America has become the greatest nation in the world—why it can produce more, better, and cheaper than any other nation—is that our scientists and our businessmen have not been afraid to dream large dreams.

I think we need to look at the pollution picture of 20, 30, 40, 50 years from now, think what our problem is going to be then, and dream a dream big enough to anticipate the needs that far away. I am confident that government funds, used in a manner designed to fully utilize American free-enterprise capability and industrial incentive, could yield technological benefits beyond our current estimates.

Working together, American scientists and businessmen have created technological capabilities which, in many areas, including, as I have just mentioned, outer space, were not dreamed of a decade ago. Let Congress and the Department of Health, Education, and Welfare set some important goals and award substantial research funds to American business and industry in order to bring their great technological expertise to bear in achieving these goals.

No Congress, no Congressman, no Senator, can look at a pollution program and make suggestions without concerning himself about the cost. As a member of the Senate Air and Water Pollution Subcommittee, I can testify that this subcommittee has been greatly concerned about the cost. We have been exposed to thousands of words of testimony concerning the need for additional research, more demonstration projects and accelerated technology, yet the entire Federal air pollution control effort calls for an expenditure of only $46 million, $66 million, and $74 million for fiscal years 1967 through 1969.

I certainly don't want any of my constituents to get the idea that I treat lightly figures as big as $46 million, $66 million, and $74 million, but there seem to be not enough funds to get the job done, compared with the size of the problem. I understand that applications for Federal program grants already exceed the total amount available for this fiscal year by a million dollars, and between 25 and 30 project applications will be turned down, merely because we don't have the funding to do the job.

Those of you who work at the grass-roots level on State and local programs know how difficult it is to get additional funds for local control programs. And this is something we have to consider when we are authorizing and appropriating funds. Given the size of the problem, I believe the sums presently devoted to it are inadequate. I would hope that those legislators who are entrusted with leadership positions in our fight against smog will not relax their efforts because of recent gains. This program must be fully funded.

This is an investment—an investment that ultimately will save millions of dollars in property, and more important, thousands of human lives. We are very much aware of the emphasis now being put on efforts to trim our budget, to lessen our deficit. I am a strong proponent of more efficiency and I am certain that we can find many programs, even the program we are discussing now, which can be dealt with more efficiently. But I think it is very obvious that if we are not careful where and how we cut our budgets, we can cut our throats at the same time.

Another problem worth mentioning is that no nationwide program that I know of is planned to insure continued effectiveness of abatement devices for motor vehicles over many months or years. Periodic inspection by qualified individuals is necessary. In some States, this can be done by adding an exhaust emission check to established safety inspection programs. However, many States, including my own State of Indiana, do not have compulsory inspection programs.

This problem must receive serious consideration if our efforts are to be truly effective. As with many problems facing us today, permanent solutions depend upon better cooperation between States and the Federal Government.

It should also be remembered that standards for levels of exhaust emission today may not be sufficient for the future. Today, we are talking about 50 to 75 percent control of emissions. But experts have estimated that about 95 percent reduction of carbon monoxide, hydrocarbons, and nitrogen oxides probably will be needed by 1985. So we have to continue to look for even more efficient ways of handling this problem.

Since the life span of the auto is about ten years, vehicles produced in 1975 would have to meet standards 30 to 40 percent more demanding than those currently required. Obviously, the task is a continuing one.

I would also urge the automobile industry to accelerate its efforts to develop pollution-free power sources for automobiles. Great strides have been made in recent months in investigating this as a possible solution to our problem.

Although exact figures on emissions of hydrocarbons and carbon monoxide from Chrysler's experimental turbine car are not available, reliable sources have informed me that emission of these two substances is considerably below current standards. At least, we know that progress has been made in this area, and we need to explore this as a possible solution.

In October of this year, Ford announced a major breakthrough in its efforts to develop an electric battery power source. In the same month, General Motors introduced its fuel-cell-powered Electrovan and a battery-propelled passenger car, the Electrovair II.

While these developments are encouraging, the road from experimental model to mass production is a long one. The complexity, size, weight, cost, and operating hazards associated with these radically new approaches to automotive travel mean that it will probably be many years before such ideas are reflected in consumer markets.

In addition, it seems to me that we must begin to study seriously the effects of any such advances on the various industries involved—the oil industry, for example, half of those whose crude oil is processed for automotive gasoline. We have to weigh the impact of all such changes on various aspects of our economy, starting now. We should not wait until a significant segment of our economy is confronted with a crisis.

We have passed through the age that I characterized, perhaps inadequately or ineptly, as the age of ignorance and inaction as far as air pollution is concerned, and I hope we have entered an age of unparallelled interest, knowledge, and activity in regard to our air pollution problems. However, the age to which we look forward, one of pure fresh air, may elude us for a great many years to come.

The ultimate answer must come from dedicated scientists, technicians, and administrators, like those attending this Conference. In many instances, those answers must be communicated to Congress and to the Department of Health, Education, and Welfare, so that your Government can do its full part.

I know of no other area in which we need so much cooperation at so many levels of expertise. All of us have great responsibilities, and we in the Congress are well aware of our own share. None of us dares to fail because we have a commitment to future generations of Americans—a commitment to purify the one natural resource which is paramount to the existence of life on this planet, our air.

QUESTIONS AND COMMENTS

CHAIRMAN BOWDITCH: The first question that I have is directed to Dr. Ludwig: "Dr. Ludwig notes that, although present controls are effective in reducing hydrocarbon and carbon monoxide emissions, they effect an increase of about 10 percent in nitrogen oxides. What can be done about the nitrogen oxides? Are automobile exhaust control devices practicable or promising against them? Is control at the refinery practicable, or do the nitrogen oxides form by oxidation of atmospheric nitrogen at high combustion temperatures?"

LUDWIG: I'd like to answer the second part of the question first, as to whether the nitrogen oxides come from the fuel or from the fixation of the nitrogen in the atmosphere. Professor Bolt pointed out in his discussion that it is the fixation of atmospheric nitrogen at the high temperatures and pressures that occur in the cylinder; the process is similar to the formation of nitrogen oxides in any combustion process.

Concerning the control of nitrogen oxides, I might say that investigations are under way today by industry and in Federal laboratories or financed by Federal contracts, to look into methods for the control of nitrogen oxides from motor vehicles. Such things as the feasibility of these methods, the amount of control that can be attained, and what this does to the operability of the car are being determined.

BOWDITCH: The next question is addressed to Professor Bolt: You made no mention of LP gas engines. How do these affect emissions?

BOLT: LP gas, meaning liquid petroleum gas, is considerably more volatile than gasoline and therefore minimizes some of the problems of the induction system which I mentioned. Therefore, it may permit somewhat leaner mixtures; it is quite well known that deposits in engines are reduced with the use of LP gas, and sparkplug life is better. So this is all on the plus side. However, I believe there is no evidence that the use of LP gas will substantially reduce the emissions, so that all of the things we've been talking about are still necessary.

DR. LEWIS CONTA (*Professor of Mechanical Engineering, University of Rochester*): The progress that has been made is certainly gratifying and the people involved are to be commended. It's clear, however, that a good deal more needs to be done and I'd like to suggest that one of the things we need to do is to change priorities. The automotive industry, in response to public demand, has for a long time based main priority on high performance and smooth operation. Very little emphasis has been put on economy and clean exhaust. Professor Bolt mentioned some of the things—the use of rich mixtures and so on—as practices which do permit higher performance and smoother operation, but which cause problems.

Engineers in the automotive industry have told me that whatever we do to improve economy or to clean up the exhaust must not interfere with performance. Now it's clear that being able to spin the rear wheels and beat the next man at a traffic light is a lot of fun, but so is breathing clean air a lot of fun, and more important than the teenage fun of beating our neighbor at the traffic light. It seems to me that this change in priorities must be established.

This will involve, as Professor Bolt pointed out, educating the public. The public must be made aware of the fact that performance may suffer somewhat. I don't think the public has ever been told so far, at least to my knowledge, that there is a connection between high-specific-output engines and exhaust emissions. I don't believe from reading the advertisements in the newspaper and listening to television that the advertisers from the automobile companies are going to take on this task, and I hope somebody does. I suppose it will be a Government agency that will have to do it.

I'm afraid I would disappoint my friend Jay Bolt if I didn't comment very briefly on the cavalier way that he dismissed stratified-charge operation of engines. I have been engaged in research on this kind of engine for some time and I'm considerably more optimistic than he is about its future, in terms of both economy and reduced exhaust emissions.

BOWDITCH: Professor Bolt, do you have any comment?

BOLT: I share with Professor Conta the opinion that high performance has been overemphasized for too long, and that a change in this practice would be desirable. I agree that the best interests of the general public have not been served by emphasis on high performance. There is much evidence that vehicles designed for and operated to obtain high performance generally have higher emissions and generate more noise, both of which must be greatly reduced in the years ahead. I am familiar with the effective experimental work of Professor Conta with stratified and spark-ignited engines. I cannot be as optimistic concerning the future outlook of this combustion system for high production automotive use.

BOGAN: I think I know what Professor Conta means by his statement about what high performance engines are costing us, but he should also tell the public that not all high performance engines emit large quantities of hydrocarbons. Some of them are very efficient, and we've got some low-performance engines. I give you some of the European engines that are having a hard time meeting the emission levels right now. So you've got to qualify generalities about the relationship between performance and emissions, and it is not a clean, straight line.

BOWDITCH: We have a question from one of the professors in the audience: "Since, as Senator Collier said this morning, taxes are so obnoxious as a means of penalizing excessive emissions of pollutants, is it conceivable that some sort of tax rebate or bonus, even to individual motorists, might be used to motivate people to utilize equipment and maintenance practices to reduce pollution?" Mr. Secretary, would you care to comment?

BOYD: There are several things that enter into this, and first of all, the matter of education which was just discussed. I'm not willing to concede that any of us is at all interested in committing suicide, even at a slow speed, and I think the implications of education in this area are very great indeed. Second, I'm sure it comes as no surprise to the majority of you that the Government historically has operated on the basis of the carrot and the stick. We pay some money, or offer some money, and then put a hooker in to make sure that the programs are carried out. So I think this suggestion is conceivable, although I question whether it's possible mechanically to handle this on an individual basis. There must be some logical basis for doing it at a level higher than the individual automobile-owner-operator or we've really mushroomed our bureaucracy.

GORDON BREAK (*Equipment Engineer, Toronto Transit Commission*): I've been in the industry for about 15 years and I've been concerned with the emissions from diesel engines for at least ten. I noted yesterday that both the Vice President and Secretary Gardner expressed amazement that a Nation that can send a man to the moon can't find a way to control diesel emissions. Several speakers this morning and this afternoon have made reference to the same problem.

In many ways, the control of diesel emissions should be much easier than the control of auto emissions. First of all, General Motors manufactures almost all bus-diesel engines so that a lot of the problems related to competitive advantages are nonexistent. Second, bus operators will willingly pay extra for a satisfactory control device, and they will also willingly maintain it properly. Third, bus operators are very sensitive to political pressures if these are necessary to force compliance with reasonable standards. And finally, we all want to get rid of the smell from our buses.

Satisfactory controls are not now available, and I believe that they will become available only when Federal, State, and local political agencies persuade General Motors to concentrate more trained personnel and spend more money to obtain satisfactory controls.

I suggest that air pollution control authorities are not being completely honest. At meetings such as these, only passing reference is made to the need for controlling diesel emissions, leaving the impression that auto and diesel exhaust problems are the same.

Privately, experts say that diesels are not a significant source of air pollution, and one of the main reasons for controlling diesel emissions is to make easier the enforcement of automobile controls.

Either use your influence on the automobile industry to develop a control method, or educate the motorist that there is no direct relationship between the pollution from his car and that from a bus, and that controls on autos are necessary, regardless of controls on buses.

". . . author of books on clean air, on water pollution, the world of computers, and the petroleum industry . . . science writer . . . technical editor . . . teacher of creative writing . . ."

CONCLUDING REMARKS

ALFRED LEWIS
Operations Editor,
National Petroleum News
New York City

Since nine o'clock this morning we have been dealing with what I think is the key item in this national conference. This may sound a little like a boy bragging about "being the biggest," but I sincerely believe that we are charged with the most critical phase of air pollution control, one that dwarfs the others in importance and complexity.

Vehicles contribute over 50 percent of the contaminants going into the air; in Los Angeles they boast (if that is the correct word) of 80 percent and the problem is compounded by numbers. Of course, it is no simple task to provide pollution controls for the hundreds of powerplants and the thousands and tens of thousands of industrial works but our task is far more formidable. It involves putting controls on the 94 million vehicles that putter and roar around our nation's network of roads and highways, and planning for the 120 million vehicles that will be on the roads in 1980.

First, there are the economic and political aspects. It apparently is far easier to sell a public utility on the advisability of investing a couple of million dollars on pollution control than to persuade the average motorist to spend $25 to $50 for keeping the pollutants of his car in check. And I believe Senator Bayh will agree that Congress finds it easier to clip the wings of Consolidated Edison, or even General Motors, than to attack the pocketbooks of several millions of red-blooded, two-fisted voters. The problem of providing for control of the Nation's cars is a big one, but it doesn't compare with the gigantic job of *maintaining* control devices on those 94 million cars, trucks and buses, and the task of *educating* the 94 million drivers to see that the work is done.

This is the nub of what several speakers have been telling you today. They have reminded us that we are not faced with a small handful of automakers and oil companies dirtying our air; the whole population is involved, as instigators as well as victims. Our first speaker, John Middleton, called attention to an aspect of this when he noted the difficulty that California has had in getting exhaust devices on used cars, and suggested that new cars will have to be more tightly controlled to offset the lack of used-car controls. Control of used cars, we learned, was not feasible today due to technical, economic, and public-acceptance considerations. My feeling is that the key words here are "public acceptance." California's Senator Collier gave us some insight on this when he told us about the old ladies, farmers, and desert hermits who were besieging him with plaints about how unfair it would be to make them put devices on their cars when they so seldom used them.

Mr. Seelig called attention to the technical aspects of this problem of the used car—the variety of cars that would have to be equipped—at a cost of $65 that might, in many cases, represent a third or more of the value of the car. But he was optimistic about our ability to accomplish this.

Several speakers this morning contributed to a broad view of how vehicles contaminate our Nation's air, with special reference to California, but also with an eye to the increasing problem being faced in our large Eastern industrial areas. And they detailed the variety of chemical compounds that are emitted by vehicles. The role played by hydrocarbons in the formation of photochemical smog was discussed and we got a number of views on the success and lack of success of the devices now in use in California. In fact, we were given our choice of percentages on how effective these controls are.

Other speakers questioned the present standards for restricting carbon monoxide, feeling that they should be far stricter in view of the accumulating evidence that continued small doses of this treacherous poison can be harmful.

Dr. Middleton took a look at other pollutants emitted from cars, oxides of nitrogen, sulfur dioxide, lead, odors, and smoke. Though they differ in significance, all of these appear to require further study. Information on lead emissions from vehicles is meager and inadequate. To date at least, what is known does not represent an indictment against leaded gasoline. Dr. Middleton notes, however, that lead in the atmosphere can affect vegetables and other vegetation, and he strongly urges that research in this field take into consideration the lead a person acquires from eating, drinking and smoking, as well as from breathing.

There were different views on what can and should be done nationally about controlling nitrogen oxides. The prevailing opinion among health people is that these gases should be controlled because of their toxicity, if not because of their role in smog formation. Dr. Middleton urged the setting up of national air quality standards, such as have been developed in California and some other States, as a means of providing guidelines for State and local authorities and helping them evaluate the relative importance in their areas of pollutants from stationary sources.

Dr. Blomquist followed, urging that we go beyond emission standards and set up goals for air quality based strictly on health and welfare considerations. These goals, although economic and technical considerations are also involved, would be our primary guides in setting up standards.

The need for tighter controls of vehicular pollution was urged by several speakers, not only because of the increasing vehicle population, but also because increased traffic congestion and more stop-and-go travel aggravate the problem. In line with this, Dr Middleton urged improvements in highway traffic laws and the development of public transport systems.

Our afternoon session began with a report from Detroit. Part of it was given in the introductory statement of Dr. Fred Bowditch, and it was detailed by Bill Bogan. Thirteen years of effort have culminated in some significant controls on both crankcase and exhaust emissions. These controls were first applied in California and soon will be compulsory for new cars nationally. The effort has taxed the energy and inventiveness of automotive engineers; they have had to start from scratch on the problem and go step by step through the development of instrumentation, acquisition of knowledge about specific pollutants, factors affecting their emissions, and finally, the development of workable control devices after many unfruitful starts. This work has been shared by government agencies, universities, and the petroleum and other industries, as John Ludwig reminds us. In fact, as he wisely notes, it has been from public agencies that have come the equally important pressure and determination to get the job done.

The main point is that although we have come a long way, we still have a long way to go. We have curbed a substantial part of the pollutants coming from the crankcase and the exhaust pipe, but indications are that more of them will have to be eliminated.

How well are California's new pollution-controlled cars performing? We heard several views today about this. Clearly, though equipped with control devices that satisfy State standards, not all indivdual cars do as well as the test samples.

Mr. Griswold suggests that the only remedy may be to test each car after it leaves the assembly line, a procedure which we hope will not prove necessary. Detroit, we learned from Dr. Bowditch, is working on better quality control. A key problem ahead is how to make sure that the control devices put on our cars continue to operate efficiently after years of service. This means a strict maintenance program, backed by annual inspections. It has to involve adequate testing equipment in the field, properly trained mechanics, and the education of the public in the need for maintenance and repair.

Professor Bolt, in a look into the future, gave us a comprehensive report on both the present piston and diesel engines and several engines that have recently been suggested as alternatives, including the gas turbine, the rotary engine, and cars powered by batteries and fuel cells. In essence, his finding is that no alternative power source on the horizon can compare with the present engine in its usable energy, reliability, moderate fuel consumption, and a half-dozen other parameters required for effective automotive power plant. His conclusion is that the engine we know so well will for many years to come, remain unrivaled for highway transportation, but that it can and should be improved to further minimize pollution. This can be done by improved engine design which involves a number of factors, including the carburetor, the intake manifold, the combustion chamber, ignition, and valve timing.

The diesel engine can also be improved, says Professor Bolt, but effective smoke reduction already can be achieved by proper fuel and maintenance, made mandatory by legislation such as Commissioner Rihm proposes for New York.

Contrary to earlier views, there is now evidence that unburned hydrocarbons from diesels can contribute to photochemical smog, and further research is required here.

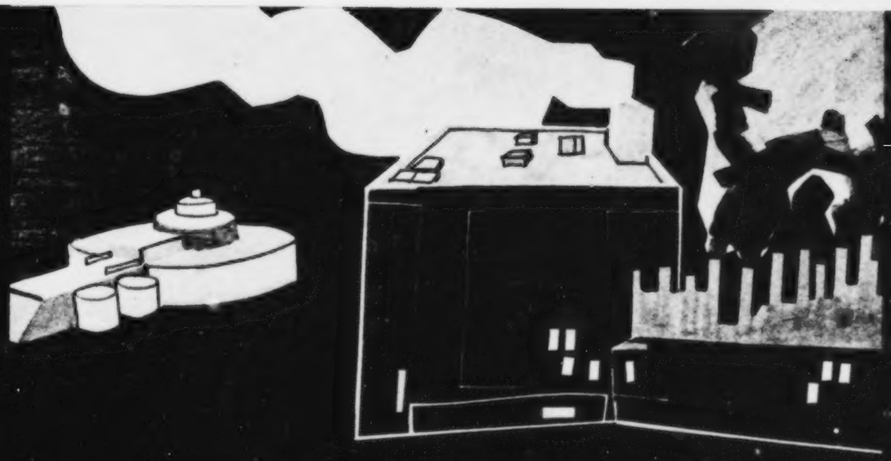
In his look at alternative engines, Professor Bolt sees promise for the gas turbine in powering trucks, many problems for the battery-powered cars, and a long-range hope for fuel cells. Electric cars powered by batteries appear some distance away, despite the recent flurry of interest. The problem is to come up with a relatively inexpensive battery that combines energy density, measured in watt hours per pound, with ability to deliver quick power.

Secretary Boyd gave us an overall look at the problem of transportation, involved as it is with changes in cities and their needs, and the changing patterns of transit systems. He cautions that a single kind of transportation system will not fit all requirements, and that transport systems must reflect the people's needs and preferences.

Senator Bayh followed by a view of Congress' mounting concern about pollution, an about-face from the past. He, too, called attention to the Nation's 90 million used cars, the need for doing something about them, and for maintaining, as well as installing, the devices on new cars.

In summary, the experience in California shows that the exhaust controls put on new 1966 and 1967 cars are effective, but individual cars vary in compliance. Tighter controls may be indicated, but the bigger need is for reliability over the life of the car. This means a strict program of device maintenance backed by policing. Coupled with this program of maintenance and inspection, must come, in my opinion, a more logical use of private automobiles. This may involve the investment of large sums of money in modern rapid-transit systems.

Some people have been suggesting that the gasoline engine can be phased out, or should be phased out. Others feel that cars should be prohibited from certain areas at certain times. Legislation of this kind would be a national calamity, a testament to our own stupidity, after the half century we have spent in developing and perfecting cars, and in view of their great value and the pleasures they give to us. The alternative is to take some of the burden off private cars by providing efficient transit systems, while at the same time providing the best possible pollution controls for the cars we now drive.



B

December 13, 1966

PANEL B

HEAT AND POWER GENERATION

FIRST SESSION

Chairman Walker Cisler
Chairman of the Board
Detroit Edison Company
Detroit, Michigan

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". . . Chief Engineer, Executive Vice President, President, and now chairman of the Board and chief executive officer, Detroit Edison . . . executive secretary of AEC industrial advisory group . . . past president of ASME . . . numerous medals and awards . . ."

STATUS REPORT

WALKER CISLER
Chairman of the Board,
Detroit Edison Company
Detroit, Michigan

May I welcome you to Panel B of this conference, which will consider government policy, the setting of standards, and the technology of control as to air pollution that results from heat and power generation.

I have been asked to review briefly the general situation at this time.

We are all well aware of the importance of industrial utilization of energy in great quantities to sustain the productivity of an industrial economy. Energy and energy-activated machines increase the productivity of the individual manyfold. The products and services so resulting cover a tremendous range of human requirements and lift standards of living for millions of people far beyond the levels of pre-industrial times. New benchmarks of human progress are established.

We can expect this development to continue at an accelerating rate in the industrialized nations and to continue to expand around the world as the developing nations change from an agricultural to an industrial base.

The favorable economic situation resulting from the extensive and broadened utilization of energy is highly pronounced in the United States where we consume more energy than any single other nation and have one of the highest standards of living.

We utilize heat energy directly for various industrial processes and for the space heating of homes and buildings. We are accustomed to high standards in comfort heating. For the American people, sweaters are more for adornment than for utility, whereas in other parts of the world in the temperate zone, room heating does not suffice very often, and the body warmth preserved by a snug sweater or coat is almost a necessity.

In power generation we place particular emphasis upon the availability of abundant electric energy. Here in the United States we have almost as much electric generating capability as in the next five leading nations combined. As of October 1, 1966 the total electric generating capacity in the nation was 262.9 million kilowatts. The Edison Electric Institute predicts that this will increase to 1.9 billion kilowatts by the end of the century. This is a vast amount of power capability indeed.

About two-thirds of the thermal electric energy in the United States is generated by the combustion of solid fuel in electric powerplants. Liquid and gaseous fuels are also used for power generation in lesser but still substantial quantities.

All this chemical process to release energy is attended by the production of gases which become atmospheric pollutants. The Committee on Pollutants of the National Academy of Sciences estimated in its 1966 publication, *Waste Management and Control,* that in a given year about 125 million tons of pollutants go into the atmosphere from all major sources. Only 12.5 percent of this comes from the generation of electric energy and 6.3 percent from space heating.

For many years the electric power industry has given thoughtful direction to the development of special facilities to reduce stack emissions, realizing this as a part of their responsibility in serving the American people. In some respects the industry has been successful. In other respects much remains to be done and the limitations are matters involving the chemical, engineering and economic fields.

Imperfect combustion produces smoke—the unburned hydrocarbons from coal and oil. Few stacks now serving modern central station steam generators show old-fashioned smoke these days except, possibly, under unusual load conditions, and then for only a relatively short period. Until about a generation ago smoke, including particulates, was considered the sum total of stack emission.

The solution of black smoke discharge has been achieved by the development of equipment that permits the more complete combustion of oil or coal in the presence of sufficient air supply to support complete combustion. It can be said that near-perfect processes of burning have resulted in almost complete disappearance of smoke emissions from electric powerplant stacks.

Another potential pollutant is fly ash and particles—the cinder discharge associated with both stoker and pulverized forms of coal firing. The central station electric industry has certainly been a leader in developing pulverizing methods for modern coal-burning and now achieves consistently high efficiency in removing fly ash before it reaches the surrounding atmosphere.

The power industry has used 90 percent of the output of dust collector manufacturers—mechanical collectors, electrostatic collectors, or the two in combination. Efficiencies of over 90 percent are now the rule, with values up to 99.5 percent in some metropolitan areas. The cost of dust collector equipment is high, representing 2 to 4 percent of the whole powerplant cost.

The technology for the collection of particulates is improving. One of the interesting developments on the horizon is the container filter house, which has not yet been put on a full-scale coal-fueled unit. When this is perfected it will be possible to remove 99.9 percent of all particulate emission.

Now we are making progress on the much more difficult and costly matter of removing the oxides of sulfur from stack emissions.

As an example of individual company action, Detroit Edison is cooperating with a steam generator manufacturer on a pilot operation at our largest powerplant. We are seeking to capture the sulfur oxides by injecting dolomite dust during the firing of pulverized coal. We find that the process is chemically and technically feasible, but we do not know as yet whether we can solve all the practical factors involved. We do know that the process increases the cost of generating electric energy.

On the industry level, the Electric Research Council, consisting of investor-owned electric companies represented by the Edison Electric Institute, and publicly financed electric systems, is engaged in a five-year research and development program in cooperation with the National Coal Association. The purpose is to develop economically feasible means of controlling sulfur oxide emission from powerplants and to determine the maximum concentration of sulfur oxides in the air at ground level that is compatible with good public health standards.

The Department of Health, Education, and Welfare is also undertaking important research in ways to remove sulfur oxides from the combustion products.

In the past, the most practical way to overcome the sulfur problem has been to utilize coal with a low sulfur content. As the demand for coal increases to meet growing electric energy requirements, it becomes necessary to turn to coal with more sulfur. Consequently, a line of research that is of great significance to the coal industry, to the utility industry and to government agencies is the endeavor to remove sulfur from coal before it is burned. Some of it comes away readily in the coal washing process, but most of it is bound in the coal in the form of pyrites. Up to this time, the removal process is costly.

A practical measure that the electric power industry has taken is to study the characteristics of powerplant stacks and how the effluent is dispersed under influencing conditions. There have been significant accomplishments in designing stack height, in nozzles for optimum plume discharge velocity and other factors. Often this necessitates constructing a much higher stack than would normally be required, with an added economic expense. Some powerplant stacks today are as high as 800 feet. Research in this aspect is being carried on by individual systems, on an industry basis, and by government.

Altogether, the Edison Electric Institute estimates that about three-quarters of a billion dollars has been spent by the electric power industry. This is a substantial amount for air pollution control equipment. Leading authorities have commended the electric power industry for what it has done in the control of pollution.

At the 1962 National Conference on Air Pollution, Mr. Harry Perry, representing the Bureau of Mines of the Department of the Interior, said: "The electric utilities industry has always been in the forefront of the industrial community in its efforts to reduce stack emissions of air pollutants to acceptably low levels."

And I quote the following from the 1964 National Power Survey of the Federal Power Commission: "Fossil-fueled powerplants consume over one-sixth of the energy released by the combustion of coal, fuel oil and gas in the United States, but they do not contribute proportionately to the nation's air pollution problems because the electric power industry has taken a leading role in pollution control."

I know that I can speak for the industry when I say that we are still not satisfied and that we wish to do everything possible to improve our record. I know this firsthand because I have grown up with the industry for more than 44 years. We are, of course, limited by the current progress of technology. To overcome this we engage in research and development in air pollution control and many other aspects of electric power generation, transmission and distribution. We have a solid record of achievement and a firm base from which to continue to go forward.

We are also limited by the cost involved in the installation of conventional pollution control of the very highest efficiency or of the newest, and as yet not fully proved, ways for removing sulfur oxides. We feel that the best answer to this is evolution through research, pilot operation and then full scale installations, rather than forced, headlong action. It would be regrettable if the matter of cost were interpreted as a delaying action, because it is not. We want equally with others to clean up the air around us. We and our families are also part of the American public we seek to serve well.

We have an equally strong responsibility, too, under the governmental agencies which regulate us, to keep the cost of electric service low. This we have been doing well indeed, in the face of rising costs and general inflation. Low cost electric energy is essential to a prosperous American economy, to the well being of the people and the strength of the nation.

In seeking to do what is best in matters of air pollution control, the individual electric systems and the industry work earnestly with governmental agencies involved. We are aware of problems that I think deserve the thoughtful consideration of this conference.

We view with concern the fact that various agencies and all levels of government are considering or making rules to establish standards of stack emission and the kinds of coal that we can buy. Similarly there are proposed, or in being, rigorous regulations as to permits for the construction and operation of powerplant equipment.

We find ourselves in the position of going to cities and townships, to the State, and possibly soon to the Federal Government, each of which can have different ground rules, to obtain such construction and operating permits. It just does not seem reasonable to need to go to four separate levels of government for permission to build and operate one facility.

Another concern that we have is that government will set emission standards that exceed what is practical today. Some of the requirements which have been proposed would make it impossible to utilize much of the coal that is available today.

It is natural for government to think in terms of laws and regulations. As a consequence, most government research money on air pollution is focused upon setting standards. Industry, on the other hand, is concentrating most of its research and development work upon advanced technology of emission control. At first glance this would seem to be a logical division of labor, but it has the unfortunate result of encouraging a dedicated, hard-working government agency to set a too stringent standard that may not respond to current technology and economics. This can upset the mechanism of balanced progress. It could result in a clashing of gears.

The Federal Government is suggesting to local governments with regulatory authority that they adopt a standard known as "equivalent opacity." This is one that has no meaningful objective measurement. In the industry we do not know how to design an installation to meet an equivalent opacity clause. The appearance of a stack plume depends upon light, the direction of the sun, thickness and velocity of the emission column, water vapor content, and the like.

A step toward objectivity has been made under the leadership of the American Society of Mechanical Engineers in cooperation with technical experts in government, utilities and industry. The result is the new ASME standard, Number APS-1, recently published and titled "Recommended Guide for the Control of Dust Emission—Combustion for Indirect Heat Exchangers." I think we need more of this kind of cooperation in setting standards that reflect the technical situation accurately and in a constructive way. On the government side, the ASME committee included the Public Health Service, the Bureau of Mines, the Department of Air Pollution Control of New York City, and the Los Angeles Air Pollution Control District.

And just as we can profit from working together on establishing feasible and objective standards—admittedly a tremendous task in so complex a field as air pollution—so, too, there is much to be said for greater cooperation in the development of advanced systems for emission control and the desulfurizing of coal and fuel oil. Some of this is being done, but I think that more public funds could be devoted to direct support of such projects. This is where the action lies in getting practical results.

I trust that these observations will set the stage sufficiently for our deliberations today.

". . . public health engineer for New York State, the U.S. Public Health Service and now the State of Pennsylvania . . . researcher in air pollution forecasting . . ."

FUTURE AIR QUALITY STANDARDS AND STATIONARY COMBUSTION CONTROL REQUIREMENTS

VICTOR H. SUSSMAN
Director, Air Pollution Control, Pennsylvania Department of Health
Harrisburg, Pennsylvania

There is an apocryphal story told about a representative of an electric utility company who, while testifying at a hearing on air pollution regulations, recommended against rigid standards because electric generation depends upon operating in a system in flux. The pun nonwithstanding, there is considerable merit to this argument.

The conversion of coal into gaseous and liquid fuels for power generation and the development of new power-generating techniques (e.g. Magnetohydrodynamic "MHD" generators and coal-fired gas turbines) can have a marked effect upon the type and extent of pollution problems associated with power generation. Arbitrary, rigid, and unreasonable air pollution control regulations could delay full-scale application of some of these new concepts.

The heat and power generation industry is presently faced with a crazy quilt of governmental regulations, restrictions, and pronouncements with respect to the control of atmospheric emissions. For example, the 1937 St. Louis regulation, requiring the washing of coal, and the 1949 Los Angeles limitations on the concentration of sulfur oxides in stack gases may appear to have established the pattern for regulations limiting sulfur emissions. But subsequent variations to these two approaches, i.e., limiting the sulfur content of fuels on a BTU or weight basis and limiting stack emissions on a concentration and/or weight basis (on occasion correlated with downwind concentrations) have produced a hodge-podge of conflicting and confusing standards and regulations.

Regulatory standards for the control of particulate matter emissions are no less confusing. In various adaptations of the 1949 ASME proposed standard of "0.85 lb. per 1000 lb. of gases," a wide range of particulate matter concentration limitations has been established by many governmental agencies. A recent approach has been the adoption of rate-weight emission standards, based upon ambient air quality criteria. Many air pollution control agencies continue to rely solely on the Ringelmann standard and also on equivalent opacity standards, as Mr. Cisler mentioned—and these air pollution standards are not uniformly applied.

This multiplicity of standards is defended on the basis that regulations must be "tailor-made" to fit the needs and desires of each individual jurisdiction—and that what may be an effective regulation (from the standpoint of the public's requirements and the governmental agencies' ability to enforce) in one community may not be effective in another community. This point is valid with respect to the control of local sources of pollution, which are economically and physically independent of similar sources located outside of the community. But where regulatory actions or industrial activities in one community can affect air pollution in other communities, the need for a coordinated approach becomes obvious.

An obvious example of this type of situation is the use of the tired, worn out, old threat by an industry to move its multimillion dollar plant out of a community (ostensibly to a less civilized community) if it is forced to spend a few thousand dollars to clean up its air pollution problems. The development of air pollution control programs throughout the nation is reducing the force (if there ever was any) behind this type of blackmail.

We are now becoming aware of some of the more subtle examples of community interrelationships involving the control of air pollution from stationary combustion equipment. The recently adopted New York City air pollution ordinance can affect the fuel economy, and thus the nature of air pollution, in the entire mid-Atlantic area. The New York ordinance and rules 62 and 62.1 of the Los Angeles Air Pollution Control District (prohibiting the industrial burning of oil with more than a 0.5 percent sulfur content on a year-round basis) have been considered relevant in deliberations by the Federal Power Commission involving the allocation of natural gas reserves. Thus, a community, by its own actions in adopting air pollution control regulations, could affect the distribution of fuels in areas outside its jurisdiction.

Recent trends toward the construction of large thermal-electric powerplants (to be discussed later) and the development of extensive interconnecting EHV transmission networks have not only created an interdependency among communities, as demonstrated by last year's East Coast blackout, but have established a condition whereby the varying pollution loads in widely separated communities are related.

Many power generating facilities, located throughout an area encompassing a number of States, are tied together by a network of power transmission lines. (According to the 1964 National Power Survey, 97 percent of the electric power industry's generating capacity is, to some degree, interconnected in five large networks.) Within these networks are located computers which automatically require more or less power from specific stations and shift power to areas of high demand. The criterion for increasing the power output of one station over another station is primarily economic. In making its decisions, the computer does not consider the relative air pollution potentials of the network stations. The computer does not consider if the station being required to increase load is located in an area experiencing a period of adverse meteorological conditions.

During the Thanksgiving Day smog siege on the East Coast, power was being generated in the New York City area, directed by computers, without consideration of the atmospheric and meteorological conditions at the time. Even though power installations in New York City reduced emissions in accordance with requests by the city's Department of Air Pollution Control, there was no coordinated, area-wide, *automatic* response to the emergency situation.

At this Conference we have heard reports of long-range research studies sponsored by governmental agencies and industry. An immediate reduction in air pollution (i.e. effects, not necessarily total emissions) can be obtained by:

1. The development of a national policy with respect to the distribution of various types of fuels so as to minimize pollution. A national policy would preclude ad hoc actions which can affect large areas of the country and are related only to air pollution problems or regulatory actions of a few communities.
2. The development and implementation of a program to include considerations related to air pollution in the production and distribution of electric power through interconnected systems.

A coordinated nationwide approach involving air quality management, the distribution of natural resources, and the production of electrical power, is possible. Because of modern fuel production and transportation techniques it is now practical to allot fuel usage on the basis of improving community environmental conditions, as well as being beneficial to the national economy. The establishment of large interconnected electric power supply networks—the largest group of interconnected systems involves 167 million kilowatts of electrical generation and covers roughly the entire portion of the United States east of Texas and the Rockies—presents an opportunity to shift air pollution loads within the area covered by the network, so as to minimize the effect of emissions from power-generating facilities.

There is no need for additional governmental legislation or appropriations to undertake such programs. Title I of the Federal Clean Air Act would permit the Department of Health, Education, and Welfare to develop and propose a national fuel distribution policy with respect to air pollution control. HEW has demonstrated its interest in FPC activities related to the distribution of natural gas. For the most part, the Public Health Service has expressed views only in connection with specific FPC deliberations involving limited areas of the country and only one type of fuel. The development of a national policy and program involving all types of fuels would provide for an equitable approach in which all communities, regardless of their size, would receive equal consideration. Equally important, a clear statement of national policy will assist both the public and the private sectors in long-range planning.

The power industry (investor-owned, State and local public agencies, cooperatives, and Federal agencies) can, in cooperation with the appropriate Federal and State governmental agencies, determine the feasibility of shifting loads within interconnected systems, so as to minimize air pollution. Obviously many factors, probably the most critical of which is the availability of reserve power, must be considered. The country's power industry, in developing the largest and one of the most efficient electric power supply systems in the world, has successfully solved many more complex problems. It is also probable that a system, whereby the sale of electric power depends upon a plant's air pollution potential, will create some "healthy" competition in developing air pollution control techniques.

The same factors which have led to the establishment of interconnected systems (i.e., the development of EHV transmission and increasing demands for power) have resulted in a trend toward the construction of larger thermal-electric power plants. Only a few years ago a 500 mw power generating plant was considered to be a giant. Today the construction of 2,000 mw plants (referred to as two gigawatt plants by the more blase) seems almost routine.

Technological developments have made it feasible to construct large coal burning power stations at the "mine mouth," and thus save on fuel transportation costs. In 1952 there were only six plants in the United States with capacities in excess of 500 mw, the largest plant being rated at 950 mw. In 1962 there were 15 stations rated in excess of 1,000 mw, three of which were rated at 1500 mw or more. Within a relatively short distance of Washington, D.C., four plants, with *initial* rated capacities between 1000 and 2000 mw are now under construction. It is generally accepted that single-plant capacities up to 4000 mw are now practical.

These huge stations present unique air pollution problems. On an annual basis, a 2000 mw station emits about the same amount of sulfur oxides and particulate matter as an industrial community of a million people. It will consume over five million tons of coal a year—more than the total (industrial, commercial, and domestic) coal consumption of Philadelphia and Pittsburgh, Pennsylvania combined.

A recent publication [1] states that:

> Although diffusion formulae for comparatively small sources have been at least partially checked against actual dispersion, similar extrapolations from existing data probably cannot be applied to estimates of pollutant emissions from plants in the range of 1000- to 5000-megawatts capacity. Plants of such sizes emit heat at a rate equivalent to the net heating by the sun over an area many hundreds or thousands of meters in diameter; it is evident that such a source will set up its own circulation pattern in the air, at least in the immediate vicinity of the plant.

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[1] Pooler, F. Potential dispersion of plumes from large powerplants. PHS pub. No. 999-AP-16.

The usual emission control regulatory standards also do not apply. A 2000-mw plant will discharge combustion gases at approximately 6 million cfm. The application of common concentration standards (gr/scf or lbs/1000 lbs of flue gas) is not justified since, at the same concentrations, emissions from one 2000-mw station will equal the emissions of approximately one hundred and fifty medium-size industrial boilers.

As combustion units (and other industrial equipment—basic oxygen furnaces, as one example) become larger and larger, the standard methods for predicting and regulating air pollution no longer apply. In Madison Avenue terminology, this is a time for "new think."

Even though there are many valid objections to specification standards, such standards (which will require the use of equipment to insure that emissions are kept to the lowest practical level) must be employed in the absence of meaningful performance standards. Regulations involving operating procedures and plant location may also be needed.

SUMMARY

There is a need to re-examine existing air pollution control regulations and standards. Although it may be reasonable to have standards vary from community to community, a more uniform regulatory approach is required. Where it is possible to predict downwind concentrations from air pollution sources, the most reasonable approach is to limit emissions to prevent community concentrations from exceeding established air quality levels. At present, very few regulations of this type have been enacted.

A regulatory approach limiting emissions alone may not be adequate to insure against air pollution from some of the newer and larger combustion units. It may be necessary to develop a coordinated program involving emission limitation standards, equipment specifications, and operational modifications. The development of electric power interconnected networks and modern fuel transportation facilities has provided the basis for a broader approach to the control of air pollution from stationary combustion equipment.

We are presently playing a "numbers game." Regulatory standards establish a number—either air quality criteria, emission limitations, or fuel specifications. These numbers are not always related to air pollution. They are often based upon outdated concepts of what is considered obtainable using good practical operating techniques. In attempting to apply these numbers, regulatory agencies and those being regulated become involved in technical arguments (which often become more philosophic than technical) concerning the application of presently relatively unreliable sampling techniques and meteorological evaluations. Regulatory action becomes dependent upon the use of one or another exponent in a diffusion formula, the application of specific analytical techniques or considerations of what constitutes "process weight." Thus, the establishment of standards does not provide the basis for control but the basis for discussion or litigation, in which the goal of preventing air pollution is often obscured.

Recent technological developments make it mandatory that consideration be given to broad regulatory concepts in the control of air pollution from fuel combustion equipment. Previous standards are no longer applicable. New approaches are possible.

DEVELOPMENT OF NATIONAL POLICY WITH RESPECT TO COAL AND OIL

STEWART L. UDALL

Secretary of the Interior

I don't know whether all of you have the pleasure of following the world as it appears to Art Buchwald, but I particularly appreciated his column last Sunday. He had a little fun at the expense of this modern world of ours. On a lecture tour last week in my State of Arizona, he arrived at one of those few towns—a mountain town—where you get a scent of a little pine in the air. Just think for a minute. How long has it been since you've been in one of those places? So he wrote a satirical column—as he does every day—telling about his experience in Flagstaff.

The airport there is far out of town and he felt somewhat strange and uncomfortable—even a little bit of a sick feeling—and he began inquiring what it was. He finally decided that the air was too pure. His lungs couldn't adjust to it and he felt faint. He arrived in the city to give a lecture, and he asked, because he really didn't feel right, whether they had an old bus or a truck he could stand near, so that he might inhale the fumes and feel normal again. He did just that, and then was able to go on and carry out his lecture schedule.

His next stop was Los Angeles, where he felt perfectly normal; he began to hack and sneeze and cough.

This, it seems to me, is a wonderful look at our modern world.

The truth of the matter is, we have emphasized and over-emphasized a high-energy, high-mobility society, at the expense of a clean society. The purpose of this conference, and the purpose of the efforts many of you are making, is to restore the balance. We assumed, even as recently as a decade ago, that in a modern industrial society as successful as ours, the penalties we had to accept were filth and waste and pollution. The rivers were dirty, and the air was fouled, and the countryside was cluttered. We accepted this as the price of progress, just as today we accept ugly billboards.

But things are changing, and this is the reason a conference of this kind is so important. We now realize that with the investment of more money, the establishment of higher standards of performance for industry, and the acceleration of research in technology, we can have a successful industrial society, with low-cost power and the right kind of transportation system, and still have a clean society.

Another thing that is clear today is that people are ready to pay whatever it costs in terms of increased power rates or increased automobile costs, or other expense. Lou Harris' poll reported recently what some of us had begun to sense, namely, that people are angered by pollution, that now they are demanding that something be done and that now this is a political issue whose intensity will grow.

The intelligent politicians are the ones who are for a clean country. Senator Edmund Muskie, who is going to talk to you tonight, is one. There's nothing he loves more—nothing he deserves more—than to be called "Mr. Clean" or "Senator Clean." Everybody likes that title, and the politicians are discovering it, so we'd better discover it ourselves.

I think we'll look back upon this period of uncleanliness in our country's history as one marked by indifference and an unwillingness to believe that we could solve the problem if we really put our minds to it and turned loose our scientists.

There are many signs of the times these days, such as the statement of Frank Stead of California—the bold, clear pronouncement that the internal combustion automobile is obsolete and will have to be eliminated in California by 1980.

The electric power industry faces such a transition, and wise executives are already moving ahead to make their future decisions compatible with the new objectives, and new national standards, the goals set out for everyone by President Johnson, the governors of States, and the mayors of cities. In the cleaning up of our air, people are already beginning to move. I think the automobile industry—judging by recent events—has got the word. They have unveiled the fact that they're doing a lot of research on electric automobiles and other things.

This is part of the whole picture, and one must have the total picture. One of the interesting things—and I do not say this to offer the electric power managers an argument they can throw in people's faces—is the realization that the transportation business is a much greater offender to our air than is the electric power industry. I am in the electric power business, too, and this does not relieve us of any responsibilities.

The new interest in the electric automobile and in nuclear power generation is a sign of the times. It is already predictable that in the large cities of our country the auto goals of the nation will undoubtedly be revised upward. We must face as fact the likelihood that only a "clean" automobile (whether the combustion automobile is cleaned up with a new technique or a gas turbine or electric automobile is developed) will be allowed in the central city. And, in terms of electric power generation in the immediate environs of cities, it will only be clean generation that will be tolerated.

One asks the questions: "Will industry suffer?" . . . "Does this put an intolerable burden on industry?" For this panel, these are key questions. I would like to say that if industry is enlightened (whether the automobile industry or the petroleum industry or the electric power industry) and begins to act now, it will not suffer. I think that tomorrow's advertising will be addressed not so much to horsepower devotees as to conscionable consumers. The ad will stress the clean car and not the chromed.

The challenging thing, it seems to me, is this: will industry look for opportunities to offset the economic costs incurred in producing clean air and clean water? Will industry look for opportunities to create byproducts? The fall issue of the *Harvard Business Review* develops this challenge.

Since the last conference on air pollution four years ago, precipitators have been developed to take the fly ash out of electric power stacks. Some companies are finding they can create brick and other products from the fly ash that was previously let loose into the air.

The recycling of wastes and the development of byproducts may mean that instead of merely spending for good citizenship, a company may get a financial return through research.

Another very interesting and clear trend, it seems to me, is in the location of new coal-fired plants. Most of them are being located in mine-mouth areas, away from cities.

In the Pacific southwest we have some of the worst air pollution problems. As a matter of fact, legal limitations now prevent the construction of most types of electric generating stations in southern California. Southern California therefore now looks to the coalfields great distances away. Extra high voltage transmission makes possible the movement of large quantities of power over long distances. And Californians, accordingly, began to look to the coalfields as far away as the four-corners area, where Arizona, New Mexico, Utah, and Colorado come together. Here there are big coal deposits, and here they found they could build large new thermal installations—750 megawatts and some of them will go to a million soon—and still achieve tremendous economies. This will actually bring the cost of power down.

This is one of the great achievements of the electric power industry in this country. Improvements in technology in this major industry have held down cost. Such tremendous economy has been achieved from these new units and the new technology that the cost of precipitators and clean generation can be absorbed and cheaper electricity can be produced.

If I were an executive in one of the large urban areas, and had one of the older, obsolete plants, I would now be developing my plans and I would be carrying on a public relations campaign to show that I knew what was needed.

Some of the enthusiasts in air pollution control have said: "Well, we ought to eliminate all other kinds of powerplants and merely have nuclear power." I do not think that from the standpoint of the long-term good of the country and the technology available during this transition period ahead, this represents sound national policy. Our coal resources represent a national asset. If we put powerplants in the right places; if we have the best equipment; if we improve that equipment as we go along, I think we can contrive to use this asset.

The problem with nuclear power is that if a utility proposes to put a nuclear plant in or near a city, where it really ought to be, people become concerned and alarmed for new reasons. They might have clean air, but they are worried over safety.

My department is planning with the Atomic Energy Commission, Southern California Edison, and the City of Los Angeles, to build the largest dual-purpose water desalination and electric power-generation plant on the Pacific coast, on an island off the California coast. Because all California is earthquake-prone, as you know, we have gone into the problem of safety. I want to say today, as a citizen who is interested in the environment and is interested in public safety and is interested in conservation, that I think we can have confidence in the safety engineering capability of the people who build nuclear plants. They have to meet high standards. In many instances, the old and obsolete plants in the city, operated by some utilities ought perhaps to come down in the near future. Maybe they ought to be replaced by nuclear plants. This might produce an alarmed outcry from people who don't understand, but I think a campaign needs to be attempted.

We have not done enough to enlighten the public on the safety problem and the safety factors that are built into the latest and most modern nuclear plants. Certainly nuclear power is the big newcomer. All the charts I've seen show that its share of the electric power market is growing, with coal holding its own or improving a bit, and hydroelectric power declining.

However, if we don't watch out, we will not fully exploit our nuclear potential because of an unfounded fear. We need to get out in the open and discuss the matter with creativity and frankness.

My own people in the Bureau of Mines have been in the field a long time, working with coal as a raw material. We believe that we can, with additional research—and we ask you to join us— take the sulfur gas and the other noxious gases out of the combustion process. It will be hard work, and the investment of money and research and energy will be considerable.

We have a much better picture today than we had four years ago—and a vastly improved picture over eight years ago. We have a concerned country; we have an aroused and increasingly enlightened industry. I think the electrical industry has shown more enlightenment than the automobile industry.

I have worked for two Presidents. I have seen their concern and the strength of their call to the country to clean up the air and the water, their call for higher goals and for a greater effort. I think we can have a clean country—that is the message I should like to leave here today.

". . . Nobel prize in chemistry . . . Enrico Fermi Award, honorary degrees from universities all over the world . . . pioneer in nuclear energy . . . chancellor, University of California at Berkeley . . ."

DEVELOPMENT OF NATIONAL POLICY WITH RESPECT TO NUCLEAR AND OTHER NEW SOURCES OF POWER

Before I discuss nuclear power in detail, I might say that the Atomic Energy Commission is turning some of the capabilities of its great national laboratories to the solution of the air pollution problem. We have asked the directors of all our laboratories to give thought to ways by which they can turn their scientific and technological potential toward the solution of this very important national problem.

Now I am going to talk about national policy with respect to the use of nuclear power to generate electricity. While our total energy requirement in the United States is increasing at a rate of about 3¼ percent a year, our demand for electricity, as you know, is nearly doubling every ten years. The current electric-generating capacity in the United States is about 250 or 260 million kilowatts, and by 1980 it is expected to be about 520 million kilowatts. It should exceed 1.6 billion kilowatts by the year 2,000.

With this as background, I think we can be grateful that, historically speaking, nuclear energy arrived on the scene when it did. The nucleus of the atom offers great promise as a major source of electric power and, as we know, that promise is being rapidly fulfilled today.

Before discussing the growth of nuclear power and the policy associated with that growth, I'd like to say a little bit about the features which make that growth so desirable.

With reference to the primary focus of this conference—air pollution—nuclear power plants offer decided advantage over fossil-fueled plants. The main advantage stems from their control of waste. Inherently, they do not have chemical combustion products as waste. In a nuclear reactor, the split atoms, or fission products as they are called, remain within the fuel cladding until such time as the reactor is ready to be refueled. Then the used fuel elements are removed and stored under water for a cooling-off period, after which they are safely shipped to a reprocessing plant where unused fuel and valuable radioisotopes are extracted for future use. The remaining waste products are then safely disposed of in storage tanks at underground burial sites.

The extremely minute amount of radioactivity produced auxiliary to the operations can be held and released in such tiny amounts and under such favorable atmospheric conditions (these can be chosen) that it poses no health hazard whatsoever.

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Or it can be packaged for safe disposal in other ways. In fact, a nuclear plant can be built without any stack at all, and such a plant is under construction today in the Rochester, New York, area.

In contrast to this, the stacks of fossil-fueled plants must release to the atmosphere effluents containing amounts of carbon dioxide which cannot be reduced, and of sulfur dioxide for which no effective removal system has yet been developed.

In addition to the direct reduction of the rate of air pollution by the use of nuclear plants, if nuclear-generated electricity could be used as the basis for a predominantly electric powered transportation system—that is, electric rapid transit conveyances and battery powered automobiles—a substantial reduction in air pollution could be effected.

Nuclear power is relatively independent of geography because of the extreme compactness and long life of the nuclear fuel and, therefore, nuclear plants can be operated far from the sources of their raw fuel material—that is, uranium and thorium ores—without a significant economic penalty.

Finally, nuclear energy lends itself well to use in large power stations, generating large blocks of very economical power. The current realization of this economic factor is the primary cause for the growth of nuclear power today and will influence the major role that nuclear power will play in the future.

I should like to focus upon some of the developments in the history and policy of nuclear power—developments that have led us to its current status, and try to answer the question, "where does nuclear power go from here?"

I doubt if it is necessary to dwell much on the origins or the heritage of nuclear power before this audience. The arrival of nuclear power technology in man's fund of knowledge was accelerated considerably by the pressures of war, by efforts carried out under a cloak of secrecy. The first public exposures to the massive release of nuclear power were strictly in terms of its awesome destructive force. This history, naturally, has left lasting impressions—and many erroneous impressions, which are unfortunately detrimental to the peaceful applications of nuclear energy. But these impressions are now gradually being eroded away through the educational process.

While the assets in the development and production capability of the wartime Manhattan Engineer District were transferred to the civilian Atomic Energy Commission in 1946, the principal occupation of the Commission for a number of years after the war continued to be related to military defense purposes.

Of course, the dream of peaceful uses of nuclear energy flourished with the first realization of the technical feasibility of the nuclear fission chain reaction as early as December 1942. While some civilian nuclear energy development projects, such as the experimental breeder reactor and the aqueous homogeneous reactor experiment, were initiated prior to the passage of the Atomic Energy Act of 1954, it was not until that legislation permitted broader declassification and broader participation by industry that serious efforts really led to major expansion.

Since that time, the transition from government monopoly to industrial cooperation and completely privately-owned plants has proceeded quickly and, in my opinion, very successfully.

The initial thrust of civilian nuclear power has been in the development of plants using light water-cooled reactors. An important contributor to the development of these reactors has been the AEC's naval reactor program. The pioneering of light water reactors—today the mainstay of the nuclear industry—was performed in the development of the nuclear powered submarine, under the direction of Admiral Rickover. A further key development was the construction of the first large nuclear electric powerplant, using a pressurized-water reactor, which began operating in 1957 at Shippingport, Pennsylvania.

Within more recent years, a broad range of technologies for civilian nuclear power production has been developed. Projects have included the design, construction, and operation of experimental and prototype reactors. The operating experience of prototype reactors on utility systems has been important to our several projects and to our overall development of the nuclear power program. Likewise, the maximum assumption of financial responsibility by industry has been, and continues to be, a valid element of providing incentive for the efficiencies and cost reductions essential to the achievement of economically competitive nuclear power.

Through this process, the industry has now reached a point at which large-capacity nuclear powerplants, employing proved light water reactors are being built, and it appears that they will be economically attractive in comparison with fossil-fuel plants in many sections of the country, including some areas where inexpensive fossil fuels are readily available.

As civilian nuclear power grows, it quite naturally will be assuming greater responsibilities in fulfilling our overall energy requirements, especially our requirements for electric energy. And as this happens, private industry's role in nuclear power will grow at an increasing rate. The Commission has been proceeding for a number of years on a course intended to permit the nuclear power industry to flourish with minimum government involvement.

One recent step taken in minimizing governmental involvement with private industry was taken with the passage and implementation of legislation regarding private ownership of special nuclear materials. By this we mean the nuclear fuels, uranium 235 and plutonium.

This legislation now permits, and by the early 1970's will require, private companies to own the nuclear fuel in their power stations. Previously, it was required that this material be owned by the Federal Government and leased for commercial use.

Another important phase of industry's participation in nuclear power was initiated this year—the operation of the first privately owned nuclear fuel reprocessing plant near Buffalo, New York. As things stand now, the sole remaining operating function for which private nuclear power is dependent upon the government is the enrichment of uranium conducted in our government-owned gaseous diffusion plants. And we have reached the point where the future possibility of private industry becoming involved in this function is now coming under serious study.

Nuclear power is beginning to pay some returns for the investment of the approximately 1.5 billion dollars of tax money spent on its development. Based on projected nuclear power growth rates and reductions in cost of power production, the returns will show the investment well justified. However, nuclear power also has certain additional developments ahead of it, and I want to focus on these in the remaining part of my talk.

These additional developments must be pursued if nuclear power is to play a major role in supplying our country's and the world's future expanding power requirements.

There is a shifting of interest toward efforts to develop reactors which will be best suited to stretch out the low-cost reserves of nuclear fuel and eventually to utilize the high-cost nuclear fuel through a more efficient use of the fuel than the present water-cooled reactors permit. Of course, no new system, no matter what its importance to the overall fuel economy, will be widely adopted if it does not itself develop electricity economically—and economically in a competitive sense. Cost, therefore, remains an important factor in our future thinking about reactor development.

With all this in mind, our major efforts are now being directed toward the development of reactor types known as "advanced converters," "near breeder" reactors, and "breeder" reactors. In order to help you understand what I mean by those terms, I think I should give you some background.

When today's light water reactors, fueled with uranium, are operated at their economic optimum, they use only a very small fraction of the latent fission energy contained in their uranium. That is the case because they are using essentially only the fissionable isotope, uranium-235, of which there is only a small fraction in the uranium, actually less than 1 percent. Should we continue to use only these types of reactors, it would not be long, in view of projected power demands, before even the large supplies of economic nuclear fuel resources known in the world today would be exhausted.

However, it is possible to convert uranium-238 and the other abundant source, thorium-232, both of which we refer to as "fertile materials," to fissionable fuel, even though they are nonfissionable themselves. This important conversion can be accomplished by transmuting within reactors the uranium-238 into plutonium and the thorium-232 into uranium-233. Plutonium-239 and uranium-233 *are* fissionable and can be used as reactor fuels. The net effect is to "burn" indirectly the nonfissionable, but very abundant, uranium-238 and thorium-232.

Most reactors accomplish this extremely productive transmutation to varying degrees and do so in the course of producing power, but water cooled reactors do so to only a small extent. Those improved converter reactor systems which produce almost as much new fuel as they consume we refer to as "advanced converters" or "near breeder" reactors.

It is also possible—and work is already under way on this—to develop reactors which, through the conversion process, produce more fissionable material than they consume while generating electricity. Here again, the net effect is to burn indirectly, but in this case almost completely, the nonfissionable uranium-238 and thorium-232. We burn them essentially completely, and these reactors are called "breeder" reactors.

The significance of the breeder reactor to the future of nuclear power lies in the fact that it is the key to unlocking the tremendous energy stored in the nonfissionable uranium-238 and thorium-232. By allowing us to make the most efficient use of our nuclear resources, this new technology gives us promise of a vast supply of economic power, a virtually unlimited supply.

The known worldwide reserves of uranium and thorium are vast, and new reserves of these ores will no doubt be discovered. But it is only through breeder reactors that a large fraction of the energy of these natural resources can be utilized and that an adequate source of energy can be assured for centuries to come.

On a worldwide basis, a few statistics clearly indicate why this is so. If we make conservative assumptions regarding these resources—for example, assuming that we utilize only the current types of light water reactors, provide for a 30-year fuel supply, and limit ourselves to natural uranium resources costing less than $15 per pound—the reserves, both known and estimated, would be sufficient for about 500,000 megawatts of worldwide nuclear power. This is a nuclear electric capacity that we estimate will be reached by about the year 1985.

Using natural uranium resources costing less than $30 per pound, that is, using more of our uranium resources, the reserves are sufficient for about one million megawatts of nuclear electric power, a capacity that we estimate will be reached by about the year 1990. However, if high-gain breeder reactors are available by this point in time—and I think they will be—then the amount of uranium available at $30 per pound or less is sufficient to operate more than 50,000,000 megawatts of nuclear power for the 30-year lifetime of the reactors.

Most importantly, the use of high gain breeder reactors will permit economic utilization of uranium costing far more than $30 per pound, and uranium of this type is available in vast quantities. This will provide a virtually unlimited source of energy. And the use of thorium with efficient breeder reactors gives rise to a nuclear fuel sufficient to accommodate an additional nuclear electric capacity comparable to that which will utilize uranium.

Developing nuclear breeder reactors, however, is not a simple matter. There are many scientific and technological hurdles which must be crossed. There are important decisions to be made concerning which reactor types deserve emphasis in our development programs. And there are economic considerations to be taken into account which have international as well as national ramifications.

Nevertheless, we have under way a program which we believe will lead to the development of a nuclear power economy based on near breeder and breeder power reactors within the next few decades. Among the reactor types under development are the reactors which we refer to as the "high temperature gas cooled reactor," the "heavy water moderated organic cooled reactor," the "molten salt reactor," and the "light water breeder"—also known as the "seed and blanket reactor." The "fast breeder reactor" is, of course, of major importance, and we have under way a major program to develop this reactor concept.

In the past two years, sales of nuclear powerplants have shown remarkable growth. Sales of nuclear plants, which amounted to a combined generating capacity of about two million kilowatts in 1963–64, rose to over five million kilowatts in 1965, and in 1966 nuclear power plant sales are approaching 20 million kilowatts. In other words, in 1966 the sales for nuclear powerplants, in terms of total capacity, exceeded the sales for fossil-fueled plants to generate electricity.

Today, as a result of the current light water reactors being sold, competitive nuclear power is bringing down the cost of electricity in this country. The development of large nuclear reactors and new associated technologies is also making feasible the construction of the large dual-purpose nuclear plant for producing electricity and desalting seawater. Such a plant, the first of its type, is currently being planned to serve the Los Angeles area, as Secretary Udall told you a few minutes ago.

As I indicated, the savings being passed on to the consumer by competitive nuclear power are paying him back for his investment as a taxpayer in developing nuclear technology. This process should continue as new and more economic plants are built.

In the future, the procedure may go one step further in bringing us benefits not even hoped for when nuclear power was first introduced. I refer here to the possibility that a very economic and efficient breeder reactor economy could bring the cost of electricity down to a level where abundant, very cheap power would have a major influence on our entire economy.

It is conceivable that the future will see vast automated industrial complexes built around large nuclear powerplants. These nuclear plants, in the multimillion kilowatt range, would be producing electricity and process heat so cheaply that they could be used to separate and recycle enormous quantities of waste of all kinds, reprocessing it together with new materials into feed materials to be fed to manufacturing plants in the same complex. They could desalt seawater and recycle sewage to give us fresh water for drinking and for agriculture. They could extract minerals from the same seawater. They could supply the electricity to produce steel by hydrogen reduction, make large quantities of nitrogen and phosphate for much needed fertilizer, and provide the heat, electricity, and radiation to process new ceramics, metals, polymers, and many new substances.

Furthermore, such a nuclear-powered industrial complex would be quiet, clean, and compact. Underground arteries, conveyor belts, and pipelines might replace the maze of roads and rails usually associated with such operations. Few, if any, chimneys would rise from this complex, in which all potential pollutants would be carefully controlled.

Since I am talking about national policy, I should add that creating such a nuclear industrial complex is not part of our national policy at the present time, but it may very well be one of our goals for the future.

I have concentrated today mainly on a discussion of nuclear power through nuclear fission. But there are other sources of energy on which I would like to touch, at least briefly. Two of these sources are directly related, solar energy and controlled thermonuclear fusion.

The fusion of nuclei of hydrogen, of course, produces the energy of the sun which supports all life on earth so that, in a sense, this source of energy is not new to us. Many advances are being made today in the direct harnessing of solar energy, and this form of energy, of course, has proved very useful in our space program. It is conceivable that increased use will be made of this abundant and low-cost energy source with the development of even more efficient and less expensive solar cells. While solar energy will never be a source of large blocks of power—that is, blocks of the size that I have been speaking of and Mr. Sussman spoke of earlier—because of the low intensity of sunlight here on earth, it may prove useful in many areas where the energy demands are moderate.

The development of controlled fusion would provide mankind with a virtually limitless supply of energy, as it would mean that we could use as a fuel the heavy hydrogen found in common seawater. It has been estimated that the energy from the heavy hydrogen nuclei in the oceans is equivalent to the energy of 500 Pacific Oceans filled with high-grade fuel oil. Such a potential fuel resource cannot be ignored.

The Atomic Energy Commission, in its controlled fusion research program, is attempting to determine whether it is possible to release this energy steadily and under controlled conditions in a new kind of reactor. Our fusion research is concentrated in four AEC laboratories—those at Princeton University, New Jersey; at the Oak Ridge National Laboratory, Tennessee; at the Los Alamos Scientific Laboratory, New Mexico; and at the Lawrence Radiation Laboratory, Berkeley and Livermore, California. Two private laboratories are also doing extensive work in this field.

Controlled fusion presents many difficult problems which may take decades to solve, but those involved in this work feel that these problems can eventually be solved and it is the policy of the Atomic Energy Commission to support and further their efforts.

My remarks today would be incomplete if I did not recognize another potential advance in conversion technology which now appears feasible and which has already been alluded to; that is the Magnetohydrodynamic (MHD) conversion. The MHD generator makes use of high-velocity electrically conducting gases to produce electric power directly, that is, without the need for a turbogenerator. If the complete promise of this new approach is realized, it can mean increased conversion efficiencies, which will have a significant effect upon our energy requirements. If we are more efficient in conversion, then we will need just that much less heat energy from whatever sources we are dependent upon. The combined use of the heat of nuclear fission and MHD conversion might produce spectacular results some day.

I have spoken only briefly today of our newest energy sources. I hope I have conveyed to you some of the progress and promise as well as some of our general policy in working with them. The job of providing our technological world with ample energy in the decades and centuries to come will be a major responsibility entrusted to those in the fields of energy resources and power technology. We must all work together with foresight and wisdom to make certain that we fulfill this obligation and thereby help man to achieve new levels of human progress.

". . . both an electrical engineer and a lawyer . . . once legislative assistant to the then Senator John F. Kennedy . . . counsel to the Senate Small Business Committee . . . on the staff of both President Kennedy and President Johnson . . ."

DEVELOPMENT OF NATIONAL POLICY WITH RESPECT TO NATURAL GAS

LEE C. WHITE
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Washington, D.C.

In order to make my own contribution to the attack on air pollution, I have agreed not to smoke any cigars during the rest of this session. This sacrifice, and for me it is a big one, is calculated to demonstrate that enthusiasm for clean air has captured public attention in a fashion that we might never have believed only a few years ago. But I hope that it will not put me on record in favor of prohibiting the smoking of cigars in all future public gatherings.

I have been asked to speak to you today on a relatively narrow aspect of the nation's growing air pollution problem, namely, the establishment of a national policy with respect to the use of natural gas to alleviate air pollution resulting from the burning of fuel to create heat and generate power. This is indeed a most significant topic and one that is receiving increasing public attention, as evidenced by this seminar.

I believe it will be useful to consider this matter first within a broader perspective. Reduction of air pollution is only one phase, albeit an important one, of society's continuing efforts to improve the quality of our environment; and pollution from heat and power generation sources is only one part of the air pollution problem. Nevertheless, attacks on pollution from these sources are important battles in the war for a more livable and enjoyable environment. The nation's industries, and those in all levels of government with responsibilities in this area, must recognize their obligations for preserving and improving our environment.

One of the major obstacles in resource management is the long lead-time between policy decision and impact. Had the counsel of a few far-sighted prophets of the past been heeded, the magnitude and perhaps even the character of our job of protecting our environment would be vastly different from what it is today. But the interest of the public is now awakened and the leadership evidenced by the President, the Congress, and the great departments of the Executive Branch is most encouraging. And I would add to that, the interest, not only of government, but of nongovernmental organizations, including the industries that have such a tremendous stake in the pollution problem.

We cannot turn back the clock, of course, but we can bend every effort to make up for lost time. I am convinced that the policy decisions made in the past few years and those to be made in the near future can and will have tremendous beneficial impact on the environment we will leave for our children and their children.

Mere existence in our many urban settings is sufficient to remind us daily of the human, social, and economic costs of air pollution. Suggestions that some health impairment is attributable to effluents in our air have been occurring with disturbing frequency. And it scarcely requires an expert to tell us that the air we are forced to breathe is at times unpleasant. Our senses are regularly assaulted by the results of certain emissions from the combustion of fuels on buildings in our cities, on our plants and trees, and on virtually every part of our environment. Because of the importance of relatively pure air to human existence and to our enjoyment of life, most of us have an emotional reaction to these disturbing and, perhaps, dangerous conditions. Hopefully, our expressions of concern contribute to the establishment of effective policies and programs for dealing with air pollution.

The Federal Power Commission is uniquely placed to consider nearly every aspect of the total public interest, including air pollution control, in electric generation and other large industries. Its regulatory jurisdiction over natural gas producers and interstate pipelines and its broad responsibilities with respect to the nation's electric power industry, have allowed and indeed required the Commission to consider the issues raised by air pollution.[1]

In my discussion today, I would like to view air pollution control in the context of a rational control policy. I hope to place pollution abatement goals in perspective in relation to other goals, offer an analytical framework within which policy towards pollution control can be considered, and discuss in somewhat greater detail the widespread substitution of natural gas for other fossil fuels as a means of lowering the level of air pollution.

FRAMEWORK FOR ANTI-POLLUTION DECISION-MAKING

The chief goal of pollution abatement is obviously to improve the present and prospective quality of American life considered as a whole. As a society, we have come to the point where we are willing to give up a great deal to be able to enjoy the benefits of an environment approaching that which our forefathers had as a natural right. I believe it is fair to say, however, that we are not willing—nor should we be—to disregard other basic needs in order to commit our resources to just this one objective.

Thus, evaluation of the costs and benefits involved is the necessary starting point for any rational analysis of pollution control. We must determine where different levels of air purity and cleanliness lie in our order of values, so that we can better understand the benefits we hope to achieve through cleaning up the atmosphere. Social benefits and costs not directly measurable in dollars necessarily are a part of any balancing process, as are recreation or flood control benefits in measuring the desirability of water power projects. Such an approach may well prove useful in weighing intelligently all of the economic, human, and social aspects of the air pollution problem.

Many regions which have progressed in dealing with pollution problems have, whether explicitly or not, essentially conformed to this pattern. It is, in effect, reducing air pollution in steps by dealing with the most costly remaining contamination by using the least costly available method until the optimum level of control is reached. Of course, policy decisions of the sort envisioned here must be based on information that is in part not yet collected and, perhaps, in part unobtainable. But with or without such data, the use of judgment in formulating air pollution control policy is essential. An analytical framework such as a cost-benefit approach can guide us in asking the right questions and in finding the right answers, but cannot itself supply those answers. Yet we should not minimize the value of knowing what questions to ask.

To tie these thoughts down, let us apply this framework to some of the specific issues of pollution control in electric power production.

POLLUTION CONTROL AND POWER PRODUCTION

There is little that I can contribute to this group toward knowledge of the technical issues involved in pollution creation and control. If my understanding is correct, however, the air pollution associated with heat and power production arises from burning the three basic fossil fuels—coal, fuel oil, and natural gas. Generally speaking, natural gas is a clean-burning, low-contamination fuel which, from the point of view of air pollution, makes it more desirable than coal or fuel oil, particularly with respect to the production of oxides of sulfur.

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[1] For a comprehensive discussion of air and water pollution at thermal-electric generating plants, see the FPC's National Power Survey, Part I, Chapter 9, 1964.

The term "air pollution" does not describe a single phenomenon which is exactly the same wherever it is found. Rather, it encompasses anything from an unpleasant odor in the atmosphere to a mixture of toxic gas, solid matter and even radioactive material. Geographical areas, moreover, differ with respect to the duration and levels of severity of pollution (including the magnitude and distribution of extremes). In some areas, notably Los Angeles, effluent emission is aggravated by a photochemical reaction of gases in the air.

Just as the condition described by the word "pollution" varies from place to place, so must control techniques. When we investigate means of alleviating pollution, an array of alternatives, each with different relative costs for each locality, presents itself. Included are such techniques as substitution of nuclear for fossil fuels, minemouth and other remote sources of power, conversion to non-sulfurous or desulfurized fossil fuels, alterations in stack height and design, and development and use of postcombustion pollution control devices.

The importance of these local and regional specifics in pollution control issues was brought home to the Federal Power Commission in its recent consideration of the Gulf Pacific case, in which air pollution in Los Angeles was directly in issue.[2] A majority of the Commission, after considering a complete record, decided not to certificate a proposal which would have supplied southern California utilities with year-round firm gas for power generation. Although the alternative project was preferred by the majority for other reasons, the Commission found that the complete displacement of oil by natural gas would have little, if any, effect on smog or on the health of the people of Los Angeles. The record indicated that more than 80 percent of the total contaminants emitted into the Los Angeles atmosphere came from automobiles and other vehicles, and, of the remainder, 16.5 percent came from sources other than power production. Thus, even during the winter months when some fuel oil was being burned, powerplants accounted for only 3.5 percent of the total emissions.

One interesting fact which the record revealed was that the substitution of natural gas for oil might even have an adverse effect on smog in the particular circumstances of the Los Angeles area, since the reduction of nitrogen oxides emitted into the atmosphere would make it easier for hydrocarbons to bring about the production of ozones and other smog-producing substances.

The FPC is fully aware that one of the important factors in determining the need for natural gas in any community is the contribution which gas may be able to make to alleviating air pollution. A showing that additional natural gas for boiler use would reduce air pollution in a significant manner would obviously merit the most serious attention. But as the record in the Gulf Pacific case shows, fuel substitution is not always the most effective or even a useful means of reducing pollution. It is clear that pollution control policies, if they are to be most effective per dollar of expenditure, must recognize that circumstances in different areas may require fundamentally different control measures.

In the interest of brevity, I do not intend to dwell on the benefits which may be expected to flow from cleaning up the air, particularly since this aspect of the subject is being covered in some detail by other speakers during the course of this conference. Suffice it to say that the high priority at present being given to this matter is a clear indication that our society has put a premium on cleaner air. While it is obvious that replacement of other fossil fuels by natural gas would reduce pollution levels in most situations, a more sophisticated evaluation is required. In order to determine in which cases fuel substitution will give us the greatest benefits for the expenditure made, attention must be given the costs of natural gas substitution as compared with other alternatives. Let me emphasize again, however, that the existence of these costs has an influence on which means we use to obtain cleaner air in different localities, but they do not alter our determination as a society to achieve it.

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[2] Transwestern Pipeline Company, Opinion No. 500, issued July 26, 1966, by the Federal Power Commission.

NATURAL GAS AND POLLUTION CONTROL IN POWER GENERATION

The considerations associated with the use of natural gas to control air pollution can be divided into two parts. The first is the extra dollar expenditure required, and the second is the use of depletable domestic gas reserves today rather than at some undermined future time.

In the absence of end-use controls or other restrictions, it may be presumed that utilities and other firms which choose to use coal or oil rather than gas when it is available, do so because these fuels are less expensive or otherwise preferable. Therefore, a decision to use gas, either because of restrictions on the types of fuels used or because of restrictions on the quantity of emissions allowed, could well tend to raise direct dollar fuel costs to these users. The amount of this cost is not easy to determine because relative prices of fuels may be expected to change if any large-scale, immediate substitution were attempted. It is reasonable to assume, however, that the change would be toward relatively higher expenditures for fuel than current direct price comparisons indicate. Increases in the direct costs of power generation could well follow widespread fuel substitution.

The higher relative price of natural gas compared with coal and fuel oil which might result from such a sudden large-scale shift in fuels, might also tend to price some nonutility uses of gas out of the market. The small users of fuel, who may not be as susceptible to administrative control, might have an incentive to shift toward the cheaper fuels. These users, with their smaller and less efficient burning equipment, could well emit more pollutants per unit of fuel than would the major fuel users. Since, in aggregate, small users do consume large quantities of fuel, the pollution-reducing effects of large-scale fuel shifts by power producers might therefore not be as great as anticipated.

A requirement to use gas within a particular region could also conceivably lead to a substantial geographical shift of power generation. Aided by the recent improvements in long-distance transmission, power companies might decide to shift their sources of power out of strict control areas by building their new plants where no pollution restrictions exist. While relocation of pollution sources is a useful technique under some circumstances, it should be noted that a requirement to shift fuels may result in unintended and undesirable relocation which moves the pollution around without reducing its dangers. These implications of required fuel substitution should alert us to the need to carefully examine the implications of this pollution control technique, as well as others, for costs both in dollars and in social costs beyond the obvious and immediate expenditures.

The cost of using domestic natural gas today rather than at some future tomorrow is sometimes considered under the general topic of "conservation," which in this context means the "correct" rate of use of natural gas. It is fair to say that this "correct" rate is not presently known and to some extent may be unknowable. It depends, among other things, on future developments of technology, on the quantity of gas that actually exists, on the rate at which new reserves can be developed and at what cost, on what alternative energy sources might be forthcoming, and on the relative importance of meeting the needs of the present generation as contrasted to fulfilling those of future generations. None of these matters is easy to balance and resolve, but actions taken each day implement an implicit evaluation in any case. This is clearly one area where we need more information.

A frequently discussed position on these matters is that speeding consumption of gas would be excessively costly and wasteful. I am not convinced that this position is necessarily correct. History has shown the remarkable success of science in avoiding resource scarcities by discovering new products and production techniques. There are numerous examples of resources which were replaced by better products long before they were exhausted, and therefore, "saving for the future need" can mean sacrificing for a contingency which never arrives. One of the saddest imaginable prospects for our civilization would be to succumb to pollution while "saving" our natural gas for a future generation that would never be born. Examples of resource waste by too rapid consumption (gas flaring, or wildlife and redwood destruction, for example) are also obvious, and perhaps emotionally more striking. History, then, gives us no clear guide. The "best" rate of gas consumption is an elusive target, but one society must consider when it contemplates large shifts in use among the fossil fuels.

I enumerate these considerations simply to illustrate that restrictions which are expected to lead to substitution of gas for other fossil fuels will have widely different effects, many of which cannot be precisely estimated. I do not want to leave the impression, however, that the additional costs which may be involved in fuel substitution or other pollution abatement measures means that we can be satisfied with dirty air. Cleaning up the atmosphere is a task of the highest priority and it requires and merits a tremendous investment. However, if our programs are to be effective, they must be calculated to return the most benefits for every dollar we spend.

CONCLUSION

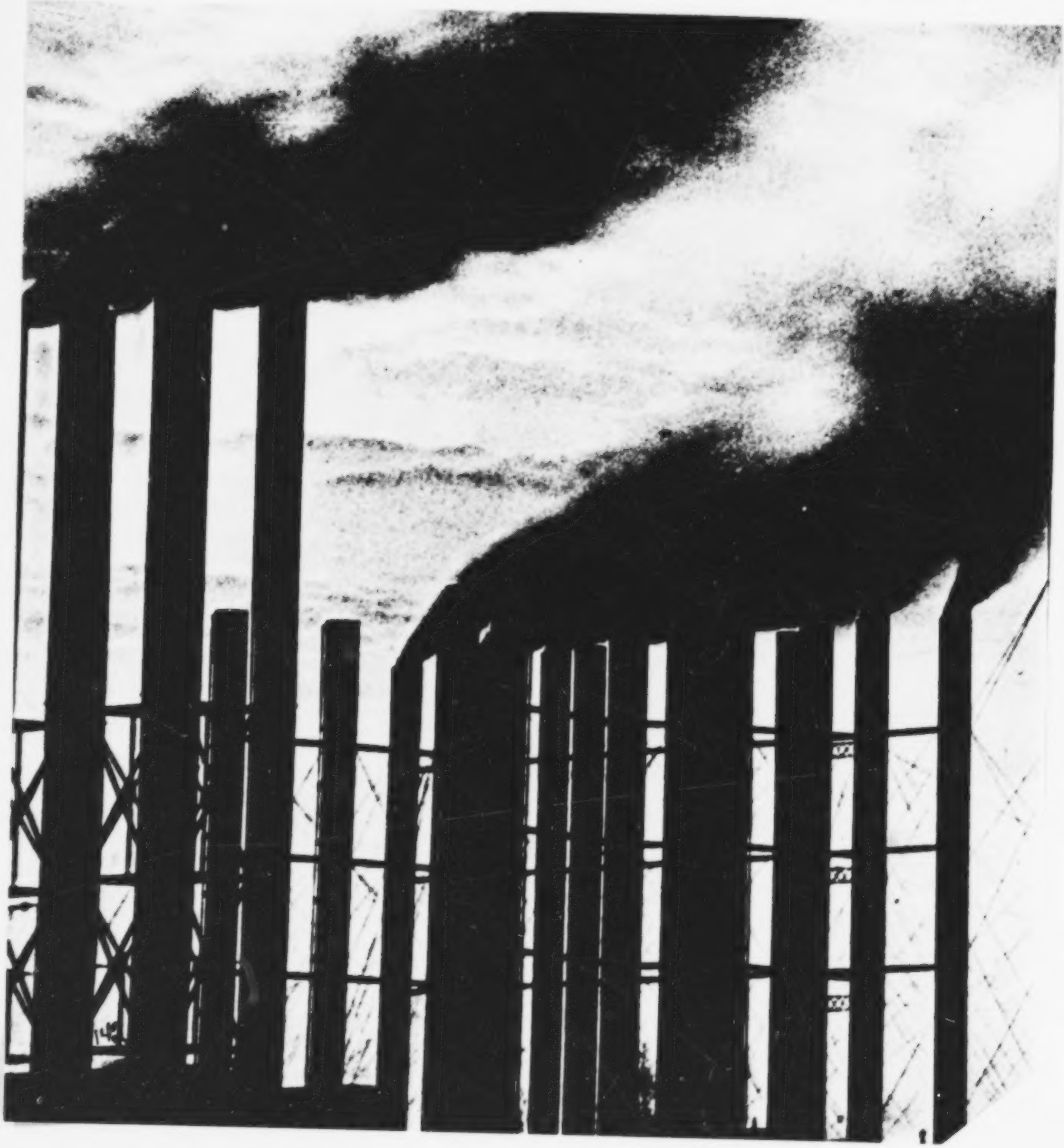
I believe substitution of natural gas for other fuels clearly has a place in an overall program of pollution control, but it cannot bear the major burden of the effort. The job is just too big, and, as we have seen, does not lend itself to a single solution. Moreover, it is not at all certain that the benefits from wholesale replacement (as opposed to specific substitution) of coal and fuel oil by gas in industrial uses would be the most effective use of gas for strictly antipollution purposes. Perhaps the dollars involved could buy us still cleaner air if they were devoted, say, to development and installation of more effective vehicle exhaust or stack emission control devices. Again we come back to the now familiar refrain: each situation must be judged individually, and given the present state of knowledge, even the best judgments are subject to continuous review in light of new developments.

At present I would summarize my views in the following terms:

1. Alleviation of air pollution is a national goal of great importance.
2. An analytical framework, such as a cost-benefit approach which includes social, economic and human factors in the balancing process, assists in formulating rational policy for control of air pollution. This approach to the selection of air pollution reduction measures will assure that our society obtains the greatest possible relief for the resources expanded to improve our environment.
3. National policy must recognize that regional specifics influence the relative importance of various means to alleviate air pollution. Each locality is unique, and must be so considered in establishing pollution abatement policy.
4. Nuclear power, relocation of power-generating plants, and additional consumption of natural gas all have a role to play in pollution abatement. I must emphasize, however, that only false hopes will be raised if these substitutes for coal and oil consumption in metropolitan areas are expected to carry by themselves a major portion of the task of obtaining cleaner air.
5. Extensive research is needed to decide the appropriate role for natural gas substitution and other techniques in pollution control. The problem must be evaluated in terms not only of extra fuel costs for given air pollution benefits, but also in terms of the cost of alternatives in fulfilling the same goals.
6. Intensified research, especially in post-combustion pollution control and in desulfurization of fossil fuels, is urgently required. Here, if anywhere, we can expect the technological breakthroughs which will significantly reduce emissions from power and heat production operations in the fore-

seeable future. High priority should be given to devices which can be installed in existing plants.

7. As we have seen, the goal of effective pollution abatement measures is to improve the present and prospective quality of American life, considered as a whole. It is my personal belief that an analysis of the growing air pollution problems, within the context of the approach I have spelled out today, will demonstrate that a reallocation of our resources, with more being devoted to combating air pollution, would enhance the public welfare.



“ . . . chairman of System Development Committee . . . former head of largest investor-owned electric utility system in U.S. . . . honorary doctorates from eleven universities . . .”

DISCUSSION OF PRECEDING THREE PAPERS

PHILIP SPORN
President (retired),
American Electric
Power Company
New York City

As one would expect, each of the three preceding papers has made a number of significant points that contribute importantly toward evolving a national policy with respect to the development of fuel and energy, especially as it bears on the question of air pollution. I think it will be worthwhile to review a few of those points specifically.

Chairman White makes the important observation that our society, in its affluence, is now willing to make some sacrifice of material goods for a cleaner atmospheric environment, one closer to that enjoyed by our forebears.

Nevertheless, we are obviously unwilling to sacrifice, and indeed we cannot sacrifice, the gains of further industrial and economic growth in favor of this one objective. Rather, some balance, as he pointed out, must be sought between the objective of cleaner air and the many other needs of our highly mobile, urbanized, and energy-driven society. He is suggesting, in effect, a system approach that considers the multiplicity of our social objectives from the standpoint of the national interest. This clearly must include the Nation's economic welfare as well as the sound and continued development of particular industries.

He also properly points out that in a country as large as the United States there is a wide diversity of regional conditions that require diversity in the treatment of the air pollution problem. This is an important observation and should serve to caution us against the seemingly easy course of imposing standardized national solutions.

Secretary Udall makes the important point, too frequently forgotten in the current enthusiasm about nuclear power, that although nuclear power is beginning to grow quite rapidly and will compete increasingly and more effectively with fossil fuels, the fossil fuels will continue to supply the major share of primary energy required for electric power generation in the years 1970–1980, and I might add, will be important for some time thereafter. As the Secretary points out, we are faced with the difficult circumstance that, although coal and oil will remain important constituents of our energy resources to supply heat and power, and there are several possible ways of reducing their sulfur content, none thus far has been found to be practical. In his own words, “insuring adequate supplies of low-sulfur fuel for eastern power plants . . . is more easily said than done.”

While the use of fossil fuels will continue to grow, the harnessing of nuclear fission as an energy source, as Dr. Seaborg has effectively noted, has provided a most timely-arrived supplement to our supply of energy. The energy of the atom has closed a potential gap in energy supply that might have caused considerable difficulty.

Dr. Seaborg has provided us with an excellent summary of the current status of the development of nuclear power. As he has pointed out, nuclear power costs are especially amenable to economies of scale and it is the growth in unit size that has made a most important contribution to the recent dramatic improvement in the competitiveness of nuclear power, so that we can now look to the next step—the breeder reactor. Here Dr. Seaborg has given us a clear statement of the rationale for breeder reactor development.

Having reviewed some of the major points made by our three speakers, we can now perhaps try to tie them together in an examination of their implications for a national policy with respect to our energy resources as they bear on the question of air pollution.

To maintain and expand still further the material welfare of our society in the next third of a century will require a substantial increase in total energy use. Whether the yearly figure be the 6 billion tons of coal equivalent suggested by Dr. Seaborg or the more conservative 4 to 4½ billion tons suggested by others, the growth anticipated compared with the current level of about 2 billion tons, is not only most impressive, but also warrants some sobering concern.

It is quite clear that with such growth the nation will have to call upon all its principal sources of energy. It will not be possible, except for the most compelling reasons, to discard any major source of energy for the purpose of maintaining clearer air. The national policy implication, therefore, is clear. A major effort is called for to assure the capability of utilizing all our energy resources while achieving the degree of pollution control acceptable to our society. Just as we have had to learn to control the deleterious effects of nuclear radiation to make available this new energy source with public safety, we have learned to control, and need to continue our efforts to control better, the deleterious effects of the effluents resulting from the use of the older energy sources.

As a matter of national policy, the full use of each of the primary energy sources needs to be fostered, subject to the full play of free market forces. No one source of energy should, or indeed can, be given a monopolistic position.

In the case of gas, as Chairman White has pointed out, to attempt to substitute gas entirely for existing fuels would impose very severe strains on the rate of discovery and on gas prices, which would be detrimental to the economy. In the case of nuclear power, obviously electric energy, to which it must first be converted, cannot yet, although it may some day, substitute for all other fuels in all uses, and it cannot yet substitute fully or everywhere, economically, for coal, gas, and oil.

Even by the year 2,000, electric energy may, at best, reach a figure of from 40 percent to 50 percent of our total energy uses. If nuclear power reaches the position of 60 percent, energy going into the production of electricity will still account for only between 24 percent and 30 percent of our total energy use.

Just to give you an example, if we take a figure slightly lower than Dr. Seaborg's, a 5000 million ton coal equivalent—bituminous coal equivalent—for total energy use in the year 2,000, and if 40 percent of that is electrical, then 2,000 million tons of bituminous coal equivalent will be going into the production of electric energy. And if 60 percent of that is nuclear, then 1,200 million tons of bituminous coal equivalent of nuclear power will go into the production of electric energy. If the figure is 50 percent, that figure is 1,500 million tons of bituminous coal equivalent per year. Notice that what we are saying is that by the year 2,000, a bare 33 years from now—from a month from now—we will be using nuclear power measured in terms of bituminous coal to an extent equal to roughly three times the total of bituminous coal that will be produced in the year 1966 in the United States—not only for power but for all other uses too.

The maintenance of low energy costs, which has had such an important part to play in the development and growth of the United States to its present position among industrial nations—and which in turn has played such an important part in the position of relative safety that we enjoy today in a very difficult world—the maintenance of low energy costs insofar as energy costs can influence industrial development needs to be protected.

Hence, the maintenance of that position, not to say its strengthening, is dependent for the next several decades upon our success in obtaining in the energy area much greater output with improved techniques in production, transportation, and use of our fossil fuels. To bring this about, research to a far greater extent that has been used in the past will be necessary, including the amelioration or elimination of the undesirable products of combustion.

But this cannot be brought about overnight; it needs some time for adequate research and development. National policy, therefore, must avoid imprudent attempts to make "great leaps forward." Rather, it must weigh and balance objectives, taking smaller steps within the limits of existing knowledge and technology, while pursuing research to extend these limits and make possible still further advances without impairing the viability of any of our energy industries. Time must be permitted for research to find solutions and to achieve economies to offset the higher costs that may be incurred for pollution control.

In the meantime, nuclear power continues to make great progress and will substitute for an increasing share of the new power generation plants to be built. Undoubtedly, its rate of substitution is being moderated by the cost burden of responsible conservatism in design and construction to assure safety—and surely it must continue to be, for a long time, part of AEC and of national policy, as it has been to date, to promote by every practical means absolute assurance of the safety of our nuclear power installations.

As I pointed out last spring in a paper evaluating the competitive status of nuclear power, such conservatism can affect the timing, but not the ultimate magnitude, of nuclear power growth. I am confident that by taking full advantage of technology already developed and by continuing research, the substantial elimination of fossil-fuel pollution can also be achieved, but hopefully at a pace that will permit adaptation and adjustments that will maintain all our energy industries in a vigorous competitive condition and will not preclude their fullest possible use.

The danger of crippling restrictions, however, is not insignificant. There is hardly an area of energy application that cannot be made the subject of restrictive practices. Since air pollution is undesirable, it can be made the basis for outlawing a specific fuel, although, on the basis of safety, all fuels—and this includes nuclear power—represent potential hazards.

It is possible, therefore, for one reason or another, to impose excessive restrictions on the use of all energy sources. But it seems to me that the net effect would only be the imposition of a most serious and detrimental handicap on the capability of our society to achieve many other objectives at least as important as cleaner air, and I do not derogate in the least the need for maintaining and improving air quality. In this respect, I stand foursquare with Chairman Lee White.

Thus, as a matter of national policy, it should be only in the event of a clear demonstration of significant damage to health, or possibly even to life, that a measure to eliminate the use of any fuel should be adopted. To do otherwise would irresponsibly, I believe, impair the Nation's welfare.

Nevertheless, such measures are all too frequently suggested, and even adopted, based on something less than adequate evidence. For example, in the case of coal, in recent years governmental regulations have been adopted, specifying either the analysis of coal or the analysis of the products of combustion at the outlet of the stack that have in effect outlawed the burning of coal even under very controlled technical conditions.

Yet it must be obvious even to a nontechnical person that the coal analysis itself does no harm or damage to anyone, nor does the effluent, whatever its characteristics, at the outlet of the stack, particularly if the stack be of a height from 600 to 1200 feet. What we are and should be concerned about is irritation or damage at the ground level to vegetable, animal, or human life. But this very simple fundamental has, in many cases, been entirely forgotten.

In the case of coal, over the past 14 years many utilities, responsive to the concern for the possible effects on the quality of the ambient air, have increased their activities much further and are doing more than the general public, and even the regulatory bodies, have been giving them credit for. Improved dust collectors have been installed and stack heights increased on many plants to disperse the effluent of combustion into the upper atmosphere. This was done long before the problem became the center of national attention.

During these years, experience in the United States and abroad has demonstrated that high stacks offer an acceptable, indeed the only pragmatic, solution to the problem of SO_2 which is available currently. As Secretary Udall has pointed out, studies of the problem of removing sulfur from coal before burning have been unavailing. Numerous studies seeking to reduce SO_2 content in flue gas involve estimated increases in the cost of fuel which make the process completely unacceptable even before the operating problems have been evaluated by actual construction and operation.

It may be that there is a finite limit to the amount of SO_2 that can be diffused to the upper atmosphere. It is possible, therefore, that high stacks can be accepted only as an interim solution. But at present they are the only acceptable solution available and for a long time ahead the diffusion limit will not be a problem. I hope that Maynard Smith will have occasion to touch on that in a paper that he is to present later in this conference.*

Meanwhile, the use of high stacks is a fully effective solution that buys us the time required to carry out the research that one day we hope will give us still better solutions. At the same time, it does not foreclose the use of any fuel. The high stack, properly designed, can without question meet every requirement—ecologic, economic, and esthetic—but of course, as with any solution, as its use is extended we must be alert to any weaknesses that may show up, so that remedies can be developed.

In summary, the papers by White, Seaborg and Udall indicate that the growth in energy use will necessitate optimum use of all of our energy resources and that ways must be found to assure the economic availability of all of them at the same time that we provide for cleaner air. While we do this, there is no threat of energy shortage.

This has been assured by the development of the new energy source, nuclear power. This energy source, operating through converter reactors, is on the way to becoming the basis of a great industry to the point that by the end of the century it will account for somewhere between 24 percent and 30 percent of our total primary energy uses.

It will have done that through a great program of research and development in which the Congress, acting through the Joint Committee on Atomic Energy; the Federal Government acting through the Atomic Energy Commission; and industry, including both the manufacturing and the utility segments, will have participated. And it will have done that by giving free rein to design ingenuity and to enterprise and by permitting the fullest development of the economies of size factor and the continual stressing of safety.

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*See page 151.

Still further assurance of adequate energy availability will be provided by the breeder reactors now in process of development. As Dr. Seaborg has pointed out, the developing of breeder reactors is not a simple matter; there are many scientific and technical hurdles which must be crossed, and there are many economic questions which have to be taken into account which have national as well as international ramifications. Yet, there can be little doubt that our basic national policy to develop the breeder reactor will succeed and expand by several orders of magnitude the energy resources available to our society.

Clearly, there need be no fear of energy shortage, provided we do not arbitrarily deny ourselves the use of any of our available resources. At present, solutions, at least intermediate solutions, are available to the problem of air pollution that would not impair the selection of fuels on an economic basis while we undertake programs of research and development to find still better and more effective solutions. There can be no complacency, but neither is there need for panic. Rather, what is called for is the research and development that will continue and expand still further the opportunities to utilize all our fuels without impairing our atmospheric environment.

QUESTION AND COMMENT

CHAIRMAN CISLER: One question has been asked that I think Dr. Seaborg would wish to answer: A few years ago the outlook for sucessfully managing liquid and solid wastes from nuclear powerplants was reportedly uncertain. What has happened to permit us to expect that increased nuclear power generation will ameliorate the total environmental pollution?

SEABORG: As a prelude to answering this question, I would like to say that I was glad that Mr. Sporn mentioned our national policy with regard to safety in the nuclear power field. I didn't have time in my brief remarks to dwell on that, but I do want to reiterate strongly that it is national policy, as implemented by the Atomic Energy Commission, to do everything possible to safeguard the public health and safety in the nuclear field. In order to assure this, the regulatory branch of the Atomic Energy Commission has a rather conservative policy.

To answer the question, I would mention two things. One is the successful operation of a number of nuclear powerplants and, more recently, a chemical processing plant, with no problems in the waste-disposal area. In the matter of storing waste, our experience has been rather substantial because we have stored waste for more than 20 years at the Hanford Production Plant without any problems.

Perhaps more important, though, has been the research program of the Atomic Energy Commission. We have spent tens of millions of dollars in the area of improved packaging and storing of atomic waste and, on the basis of the results, I am quite confident that the aspect of safety and the prevention of pollution from atomic waste will be satisfactorily handled in the future.

B

December 13, 1966

PANEL B

HEAT AND POWER GENERATION

SECOND SESSION

Chairman Gabriel O. Wessenauer
Manager of Power
Tennessee Valley Authority
Chattanooga, Tennessee

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" . . . engineer and power authority . . . vice-chairman of electric research council . . . director of defense electric power administration for a large region . . . public service award for outstanding service to the Nation . . ."

INTRODUCTORY STATEMENT

GABRIEL O. WESSENAUER
Manager of Power
for Tennessee
Valley Authority
Chattanooga, Tennessee

This morning we had presentations dealing with the development of national policy with respect to coal, oil, natural gas, and nuclear and other new sources of power. This afternoon we will examine the current status and future prospects of air pollution control in the generation of heat and power, and the opportunities for improvement and acceleration of control efforts. Our speakers will discuss high stack as a means of controlling ground level concentrations of stack effluents and the status of technology for removing from stack gases these constituents believed to have deleterious effects on the environment. These constituents are sulfur dioxide, fly ash, and nitrogen oxides.

Our speakers will present a good picture of where we stand with respect to plant control techniques for both existing and authorized fossil fuel plants. It is not the complete story. Several other factors have an implicit bearing on environmental pollution from thermal sources—namely, the growth of nuclear power; the trend toward large and remotely sited thermal plants; the growing use of electricity for heating homes, factories, and offices; the promise of the electric automobile; and the changing use patterns to which existing sources of pollution would be relegated.

Each of these will result in some abatement in the levels of pollution that would otherwise exist in urban areas.

While the theme of this conference is centered on the word "control," basic questions remain as to the proper limits of these controls. Research on the physiologic effects of very low concentrations of air impurities, singly and in any of a multitude of combinations, must continue. While only passing reference might be paid in this afternoon's discussions to this basic fact, uncertainties will exist as to the justification for money spent for control until more factual evidence is at hand on effects.

" . . . research meteorologist . . . carried on research in urban atmospheric analysis and forecasting, dispersion of releases to the atmosphere from elevated sources . . . with Brookhaven since 1948 . . ."

REDUCTION OF AMBIENT AIR CONCENTRATIONS OF POLLUTANTS BY DISPERSION FROM HIGH STACKS

MAYNARD E. SMITH
Leader, Meteorology Group, Brookhaven National Laboratory
Upton, New York

In the past fifteen years the high[*] stack has become almost symbolic of good industrial air pollution practice, and its use as an effective and economical device for reducing ground-level air pollution has become widespread. Although this session deals specifically with heat and power, the discussion is applicable to any similar operation. My principal purpose is to specify what a stack can and cannot do, and to emphasize several important, unresolved questions upon which the ultimate value of the stack depends. The data that have led to my conclusions have come from too many sources to permit complete references, but bits and pieces have been extracted from a surprising variety of research projects. These projects have usually been conducted exclusively within a single administrative domain, and it has occurred to me many times during my preparation that we are in need of "integration" in this field also. There is much important, expensive work to be done, and I am firmly convinced that we will make more rapid progress and achieve better understanding by means of genuinely cooperative projects, with staffs and facilities dictated by technical requirements rather than organization boundaries.

I should also admit before you remind me that much of my material is not new. The author of a "state of the art" paper always feels obliged to dig through the dusty files to make certain that he does not ignore significant contributions, and incidentally to be sure that he does not display any lack of erudition himself. In my case, the digging process has been humbling as well as helpful since it has reminded me once again that several early workers in this field understood, and eloquently expressed, most of the points I hope to make clear.

As far as I can determine, the first genuine devotees of the high stack were not in the heat and power field. Long before most of us had begun to think of a stack as something more than an aid to combustion draft, the American Smelting and Refining Co. was creating traumatic shock by using 400- to 600-foot chimneys to reduce sulfur dioxide pollution from smelting operations. I remember vividly some disparaging remarks that accompanied their pioneering papers, and this accounts in part for my satisfaction in being able to recommend to you a re-reading of the 1945 paper on high stacks by George Hill, Moyer Thomas, and John Abersold. There are earlier works on the subject to be sure, but this paper is unique in firmly establishing the value of the tall stack by means of thorough field investigations. It is also noteworthy for its recognition of the importance of maintaining buoyancy in large-volume plumes (some of us have had to relearn this lesson), and for clearly stressing the difference between average and peak concentrations, especially in light winds.

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[*] Any definition of a "high" stack is arbitrary, but in this paper it is one reaching 500 ft. or more above ground.

One cannot conduct any review without including Hewson's classic study of the plumes from the Trail smelters (1945). His description of the Columbia River Valley circulation and its effect on the ground-level SO_2 concentrations is still pertinent, especially since little work of equivalent quality has been performed in valleys since that time. Hewson was also a pioneer in drawing our attention to the "fumigation" condition, which was a significant factor in the Trail problem and remains an important problem today.

The electric power industry seems first to have become enchanted with higher stacks for the solution of the aerodynamic downwash problem, which was very common with the typical "75-ft building, 100-ft stack" power station of the 1920–1950 era. In fact, the University of Michigan and New York University wind tunnels were used so successfully to determine the stack increments required to alleviate these high-wind problems that we meteorologists had some difficulty in convincing power company executives that even taller stacks might provide additional benefits.

I had the pleasure of being associated with one of the first studies of a major fossil-fuel plant completed *prior* to final design and construction. This study of the Clifty Creek plant in the Ohio Valley included both wind-tunnel tests and a theoretical evaluation of ground-level SO_2 concentrations and dustfall. The program also provided for another unusual feature—continuous monitoring of the field SO_2 concentrations and dustfall after the plant was completed. It is gratifying today to direct your attention to the paper that Frankenberg and Sporn recently presented in London (1966), as proof that the 680-ft stacks have performed as anticipated, except that the "inversion breakup fumigation" concentrations predicted in the original study have not been observed.

Today, almost every major powerplant designed for fossil fuel includes a stack chosen to keep ground-level pollution within acceptable limits. Formal study of individual plants varies according to the complexity of the area, the size of the plant, and the sophistication of the organization, but the air pollution abatement function of the stack is as much a part of the design consideration as are boiler and turbine details.

The trend in the industry is clear enough—fossil fuel plants are constantly increasing in individual size as power requirements and economics dictate. Stack heights are increasing also, in response to the trend in plant size and in recognition of the need for maintaining lower ambient air concentrations. The new Bull Run plant of TVA and the Cardinal plant of the American Electric Power system will have stacks reaching the 800-ft level, and 1000-ft stacks will soon be seen in western Pennsylvania. If one needs further proof, Olmstead (1966) tells us that the average height of stacks to be completed in 1969 for coal-burning powerplants will be 609 ft as compared to 243 ft in 1960. Faced with such an obvious trend, we should indeed be asking ourselves what stacks can and cannot do. We have acceptable answers to many specific questions, but there are important aspects of the behavior of stack gases that remain poorly defined.

There are several benefits to be obtained from the use of a tall stack (or any stack for that matter) about which no one will argue seriously. Experts are not in perfect accord about the exact degree of benefit or the manner in which it may be achieved, but there can be no quarrel over the reality of the effects.

Under *any* meteorological conditions, a tall stack located in open, uncomplicated terrain will produce a dramatic reduction in the local ground-level concentrations of gases or small particulates compared to the same emission released at low levels. The

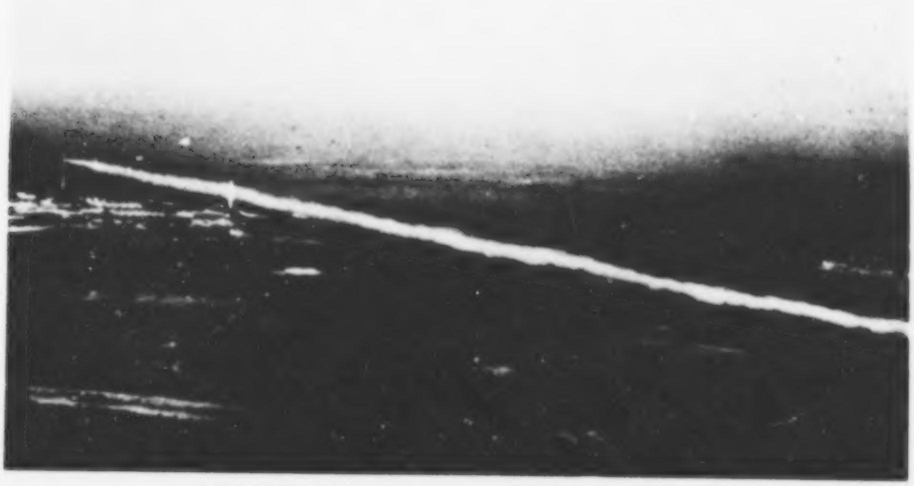

FIGURE 1.—Inversion smoke trail.

Oil fog trail shortly after sunrise during a deep, temperature inversion extending well above the smoke trail. The source was at 108 m and 3 miles of trail are visible.

degree of reduction and the size of the area over which it occurs are dependent upon the stack height, the distance from the source, and the meteorological conditions, but there is always a region near the stack where the improvement is impressive. This reduction is accomplished simply by giving natural atmospheric turbulence an opportunity to dilute the pollutant before it reaches ground-level receptors. In Table I, for example, the maximum concentration at ground level under typical daytime conditions is reduced by a factor of 100 by a tenfold increase in source height. Significant though much smaller reductions occur as far as 10 km from the source.

It is also important to realize that a stack located in open terrain converts the least favorable meteorological condition into the most favorable. Within a well-developed temperature inversion, the mixing process is extremely slow and ineffective, particu-

TABLE I.—*Calculated ground level concentrations from various effective stack heights*

	Distance of maximum (km)	Concentrations directly downwind (ppm.)				
		Maximum	1 km	5 km	10 km	50 km
Typical daytime conditions:						
Effective stack height 1,000 m	7.6	0.03	0	0.03	0.03	0.004
Effective stack height 500 m	3.4	.14	<.01	12	.05	.004
Effective stack height 100 m	.6	3.36	2.2	.19	.06	.004
Effective stack height ground	(1)		3.6	.19	.06	.004
Surface inversion conditions:						
Effective stack height 1,000 m	(2)		0	0	0	0
Effective stack height 500 m	(2)		0	0	0	0
Effective stack height 100 m	(2)		0	0	0	.03
Effective stack height ground	(1)		1,590	161	60	6.0

[1] At source.

[2] Beyond 100 km

NOTE.—While the SO_2 emission rate of 8×10^5 cm^3/sec is typical of a 600 MW—2 percent S plant, the source heights are chosen to illustrate the problem and not to represent typical stack plumes. For example, it would be almost impossible to have an effective source height at the ground with the large heat release of such a plant.

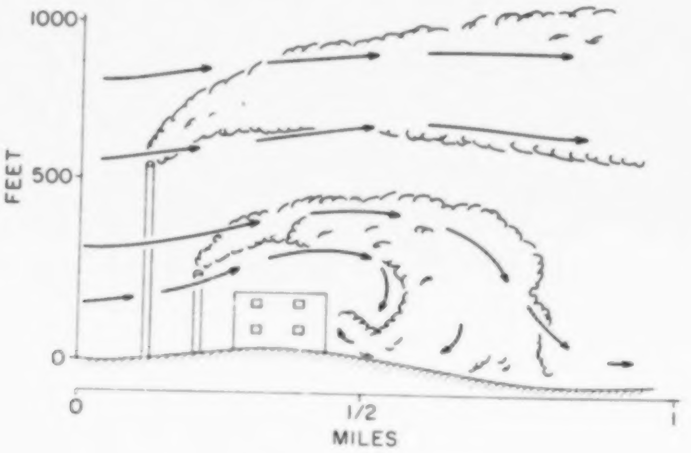

FIGURE 2.—Aerodynamic downwash.

Standing eddies in the wind flow behind the building bring pollutants from a low stack quickly to the ground.

larly in the vertical. For all practical purposes, a plume emitted at any reasonable height above ground in an inversion remains aloft indefinitely, producing no ground-level concentrations, as indicated in the lower section of Table I. A photograph of such an inversion plume (Figure 1) shows that concentration within the plume changes little with distance, but it remains aloft.

A stack can be a most effective tool for removing a plume from a specialized local wind circulation that tends to bring pollutants to ground level in higher than normal concentrations. Even an elevated source in the lee of a large building or terrain obstacle, as in Figure 2, may produce undesirable effects nearby, whereas an isolated stack would not. This is the classic aerodynamic downwash problem mentioned earlier, and the solution is usually an increase in stack height sufficient to remove the plume from the offending circulation.

While the typical downwash problem is easily solved by a wind tunnel study, there are other types of local circulations which are difficult to model. It is clear, for example, that a significant portion of the difficulty experienced with the Trail smelters resulted for specialized circulation in the Columbia River Valley, as indicated in Figure 3. Patterns of this type are not so easily recognized, nor can they be represented in tunnels since they are primarily thermally-generated phenomena associated with light winds. The problems they might create are often solved automatically, however, since the requirements for a high stack based upon conventional analysis will frequently remove the effluent from a low-level system of this type.

This list of positive accomplishments of the tall stack is short, but it is unquestionably impressive. In the local area near a large pollution source, the only possible alternative would be reduction of the emission by the huge percentages suggested by Table I, and it would seem that our technology is not quite equal to the task as yet.

Having extolled the virtues of the tall stack, we must also keep in mind the things it cannot do. Influenced by knowledge of its real benefits and perhaps sometimes by wishful thinking, we often find the tall stack receiving credit for purely fictitious accomplishments. I remember an early press story about Brookhaven's Graphite Research Reactor as a classic example—it stated boldly that the reactor would operate only when the radioactive Argon gas from the stack dispersed upward and would not come to the ground. I remember equally well four long-faced meteorologists wondering how they might answer queries based on that misconception.

The fact of the matter is, of course, that stacks possess no magic power to eliminate

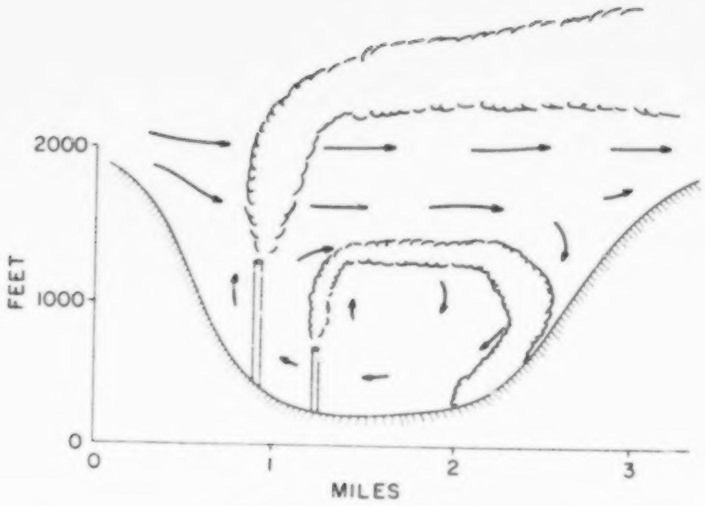

FIGURE 3.—Valley circulation.

Local circulations caused by unequal heating and cooling within valleys may create unusual dispersion patterns.

a pollutant. They do not reduce by one gram the total amount of pollutant released to the atmosphere. They distribute it in a different way than would be true of a low-level source, but a receptor at a great distance from a stack will receive substantially the same concentrations no matter what the source height. Both Table I which illustrates the hypothetical effect of varying source height and Table II which depicts the performance of an actual powerplant stack show this effect clearly. This failure to effect a widespread reduction is the essential reason for continued emphasis on restricting the total amount of emissions by those concerned with large-scale pollution problems. It is a valid reason as long as the pollutant does not change to a less objectionable form while airborne, but this possibility will be discussed more fully in a later section.

There is one popular misconception closely allied to the local *vs.* regional controversy that should be firmly quashed, and that is the idea that a stack merely transfers a given pollution problem from one area to another. This idea probably originated with the change in the position of the maximum concentration as the stack height increases. What is often ignored is the fact that the magnitude of the ground-level concentrations decreases everywhere as the stack height increases, as is clearly shown in Table II. True, at 20 km one may not be able to measure the decrease in concentration associated with a small increase in stack height, but the tendency is always to reduce, not to increase the concentration. Another possible source of this misconception is that a change in stack height may involve a change in wind direction so that the pollutant reaches a different area as the stack height changes (Figure 4). This still does not imply that increasing stack height means higher levels of concentration.

We have a common view in this country that if one unit is good, two will be twice as good, ad infinitum. Automobile horsepower and cigarette length are sufficient examples. Looking at any of the equations developed to represent the maximum concentrations from a stack, we find a $1/h^2$ term (h is the stack height) which implies that we are even better off with stacks, since doubling the height of a stack should reduce the concentration by a factor of four. As with dry martinis, the approach has certain flaws, particularly when applied to large powerplants whose stack emission includes a very substantial volume of hot gases. With such plants, the true source height is achieved by an addition of the actual stack height and a combined momentum-buoyancy rise of the

TABLE II*.—*Calculated concentrations at the maximum, 10 kilometers and 20 kilometers from a 600 mw source in typical daytime conditions*

Actual stack height		Distance of maximum kilometers	Concentrations (parts per million)		
Feet	Meters		Maximum	10 kilometers	20 kilometers
750	230	4.0	0.10	0.044	0.015
600	185	3.6	.13	.045	.015
500	155	3.2	.15	.046	.015
400	120	3.0	.18	.046	.015
350	105	2.9	.19	.047	.015
300	90	2.8	.20	.047	.015
250	75	2.6	.21	.048	.015
200	60	2.5	.22	.048	.015

*Unlike table I, these data reflect the natural rise of the gases above the stack top, which for the postulated 6 m-sec wind, amounted to an additional 300 m.

gas, and the latter is an appreciable quantity. From a 600 MW plant with a typical gas emission, for example, the plume rise ranges from a few hundred feet in strong winds to thousands of feet in light winds. Thus a substantial addition to stack height does not produce quite the effect that a cursory examination of the equations might suggest, since the plume rise is a much larger number than the stack height. Furthermore, as larger plants are constructed with commensurately higher chimneys, it appears that the limiting meteorological condition (i.e., that producing the highest ground-level concentrations) tends to become associated with light winds and strong vertical mixing. Any theoretical evaluation which includes the buoyant plume rise will predict this result, and Gartrell (1966) has found it to be true in practice. This light-wind condition is precisely the case in which the buoyant plume rise is greatest and the effect of an addition to the physical stack least.

There must therefore be a practical upper limit to the maximum powerplant stack height and size when one considers these diminishing returns together with questions of cost, construction difficulty, and aircraft hazards. What this size limit may be depends on the amount of pollutant in the emission, the frequency of the unfavorable meteorological conditions and the definition of acceptable concentration levels. It also depends on the answers to a number of questions that have not yet been answered to everyone's satisfaction, and it seems that a review of these questions may be the most valuable contribution that I can make at this conference.

In view of the two preceding paragraphs, the most obvious problem to single out is the prediction of plume rise. Over the years, we have been deluged with theoretical and empirical formulas predicting the rise of a plume having both momentum and buoyancy, but even today we have little good field data to help us choose among them. I know from personal experience how difficult it is to assess the rise of a cloud or plume which is simultaneously being dispersed by natural turbulence, but we must achieve more reliable prediction of this phenomenon. At the most recent ASME meeting in New York, the Task Group charged with preparing the Guide for Atmospheric Dispersion reported upon still another formula, and while we believe it to be the best available, we recognize that it is not in full accord with all data or viewpoints. The principal bone of contention is whether the heat release rate should be raised to the ¼ or the ½ power, a difference which implies variations of hundreds of feet in effective stack height for the large powerplant plume.

Extension of any formula to multiple stacks is even more speculative. Fortunately, we do have some helpful data from TVA (Gartrell, 1966) but much of it is in terms

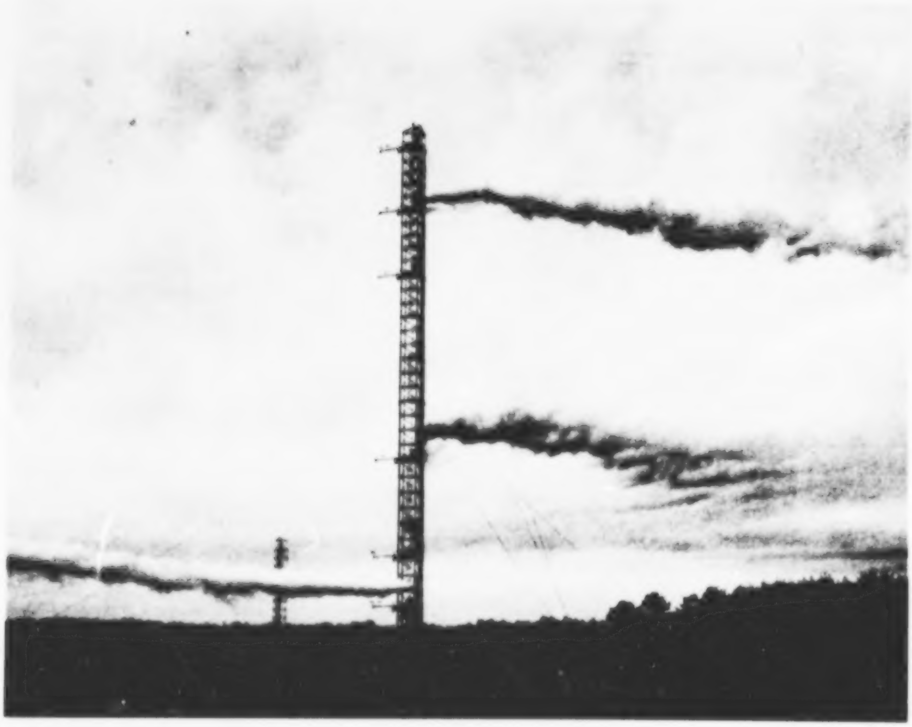

FIGURE 4.—Change in wind direction with height.

A change in stack height may change the location of pollution. The three smoke trails shown were emitted during a temperature inversion at 50, 150 and 350 ft. above ground.

of ground-level concentrations rather than plume behavior itself. Perhaps we could avoid this research problem entirely by using the compartmented single stack now favored in Britain, but we still have many new multiple stack plants under design.

I feel sure that my colleagues agree that much remains to be learned about plume rise, but wonder if I am not emphasizing unnecessarily a problem which we can at least treat fairly well. There is reason for the emphasis, however, because estimates of plume ascent are vital to a crucial question, that of the fumigation concentrations from power plant plumes. If one were asked to choose two words from an air pollution glossary guaranteed to strike terror in the hearts of the populace, he would have a hard time selecting more effective ones than "fumigation" and "inversion." The wide publicity given inversions in relation to the specialized problems of Los Angeles, and the lethal connotation of fumigation have given the two words stature. It is little wonder, therefore, that the pamphlet published by Pooler (1965) has caused widespread concern, since he described a calculation method for an "inversion break-up fumigation" which predicts very high ground-level concentrations in the morning hours immediately following the destruction of a surface temperature inversion. All such calculations (and there have been many) assume that a narrow pencil-like plume such as that shown in Figure 1 is mixed downward into the air below, but not upward because of an inversion remaining aloft. The details vary in how thick a layer may be involved, how much of the plume may penetrate into the inversion and how wide a swath may be affected, but the picture to keep in mind is one of a large amount of SO_2 confined to a small volume close to the earth's surface.

The essential question is not whether such a process can ever occur. Certainly, the Trail experience was related to phenomena of this type, and measurements of cool oil-fog plumes at Brookhaven Laboratory have shown that it can (Lowry, 1950). Rather, the question is whether such phenomena are found with the typical large powerplant plumes, and if so, under what conditions and how often.

There are several reasons for caution about accepting the validity of such calculations for large emissions. In the first place we know that these plumes may reach altitudes of 1000–2000 ft above the surface, and while the flow at these heights is still technically a part of the planetary boundary layer, it is often in a transition zone between the region close to the earth's surface and the free air above. We have not studied the turbulence in the higher layers in any detail as yet, and extrapolation of our knowledge of the lowest 500 ft to much higher elevations is not without its dangers.

It is also true that the typical radiation or surface inversion usually appears as a layer reaching only 500 to 1000 ft above the surface, but the large powerplant plume is likely to penetrate a relatively weak inversion layer (if any) remaining above it. Whenever this happens, and it probably is a common occurrence, the plume approaches the ideal of dispersing upward but not downward.

Furthermore, most radiation inversions probably do not break down in quite the orderly progressive manner initially supposed by many of us, wherein an unstable layer gradually builds up from the surface while a portion of the inversion remains above it. On the contrary, it is highly likely that upward dispersion begins at about the same time as downward dispersion for plumes that are already high in the air.

The most compelling reason for caution is that experience with several large powerplants has failed to show fumigation concentrations of the order predicted. Initial calculations made for the Clifty Creek and Kyger Creek plants included inversion break-up estimates of my own devising, which, like a contemporary development by Hewson (1955) and Pooler's recent system, predicted concentrations of 2–5 ppm. Frankenberg and Sporn (1966) report that four years of continuous monitoring failed to verify the prediction at any time at either plant. Martin and Barber (1966) in an intensive study of a modern 1000 MW plant in England also state that "No unusual station effects were observed at the break-up of inversions, with the present recorder array." Similarly, Gartrell reports a peak observed value of only 0.6 ppm for a 1250 MW plant equipped with 500-foot stacks over a 19-month period. With the 3 percent sulfur coal burned, Pooler's inversion fumigation calculation predicts 3.0 ppm and his "light wind fumigation" at least 2.0 ppm for Gartrell's example.

It can be argued that fumigations occur infrequently and that one must sample in just the right place at just the right time to observe them, but if years of continuous sampling at a given site do not reveal such high concentrations, one wonders whether the calculation is valid. The essential questions are (1) whether these large plumes often penetrate relatively low or weak inversion lids, and (2) when they are trapped below such lids what precisely is the nature of the dispersion.

Another important area of uncertainty that probably will be with us for a much longer time involves atmospheric flow patterns associated with terrain features that are of very large scale. I have already indicated that the Trail experience seems to have been one of those specialized cases wherein the highly concentrated plume was trapped in a major valley circulation with unfortunate results. There are other studies as well which indicate that we may be in for some rude surprises if plants are built in very rugged terrain. Smith (1965), for example, has reported that under certain stability conditions tracers released high above and upwind of a ridge top have appeared far below along the lee slope, although they certainly would not be expected there on the basis of standard calculations. Figure 5 shows the wave type of flow pattern that Smith found. Sea and lake breeze circulations are in this same large-scale category, and it would not be surprising to find significant departures from standard diffusion calculations associated with them, especially as plants become larger. We cannot yet generalize reliably, but we must be careful to investigate actual flow patterns before construction in complex areas.

There is one additional problem about which very little has been said to date, and that concerns the atmospheric half-life of contaminants such as SO_2. Obviously most pollutants do not remain in the atmosphere indefinitely; we would all have ceased to exist centuries ago if this were true. A variety of chemical and physical processes alter the pollutants and eventually return them to the earth's surface. These processes have typical time scales that are fairly short, generally not more than weeks and sometimes as short as a few hours. If atmospheric processes which reduce the objectionable character of a pollutant produce half-lives of 12 hours or less, we must revise our earlier statement that stacks fail to reduce total pollution over a large area. Because tall stacks typically cause pollution to remain aloft for long periods, even for an entire night during an inversion condition, it is quite possible that they also have the effect of reducing total amounts.

To summarize, the power industry has found the tall stack to be an excellent means of reducing ground-level pollution, producing a greater effect per dollar spent than almost anything else. While the stack may not eliminate the overall burden of pollution borne by the atmosphere, it will remain an important feature of our anti-pollution efforts until much more practical and reasonable means of reducing emissions are at hand.

Perhaps the most critical problem today is to determine the limiting size of a single fossil-fuel plant, and among other factors this depends upon an accurate assessment of stack performance. Differences in dispersion calculations alone cause such estimates to vary by almost an order of magnitude. Resolution of these differences depends upon finding the answers to questions such as those I have raised in this paper, and it is clear that we are not going to obtain the answers through haphazard research oriented toward minimum cost and organizational secrecy rather than accurate, pertinent data.

The Task Group preparing the new ASME Dispersion Guide was initially naive enough to believe that ASME prestige and influence might flush enough good field data from dusty files to permit reasonable verification of the evaluation procedures that are to be recommended. With a few signal exceptions, this part of the work has been a dismal failure, and we cannot offer much more than one can find in the existing open literature.

We urgently need answers to these questions and it is time to undertake imaginative projects that will provide them. The recent proposal for intensive study of

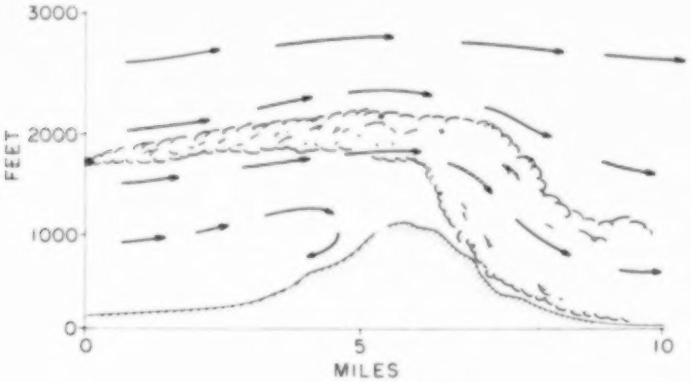

FIGURE 5.—Large scale wave pattern.

Flow patterns associated with major terrain features may cause pollutants to reach the ground in unexpected areas.

the 1000 foot stack plumes in western Pennsylvania is cast in the proper mold. Originating within the Public Health Service, it cuts across organizational boundaries to include government, industrial, university, and private personnel and facilities in a joint effort to obtain the desired data. As emphasized in announcements for this conference, it certainly "will take the combined efforts of industry, government, science, and the community to conquer the problem."

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REDUCTION OF AMBIENT AIR CONCENTRATIONS OF SULFUR OXIDES—PRESENT AND FUTURE PROSPECTS

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INTRODUCTION

The problem of air pollution from sulfur oxides is one of the most serious that we face today. The problem is growing rapidly—so fast that we must greatly accelerate the work to develop means for reducing the output of sulfur oxides from all domestic and industrial sources. Many of our cities suffer frequent exposures to ambient concentrations higher than recommended levels. At our present emission levels we are already experiencing many demonstrable adverse effects: damage to human health, destruction of property, and reduction of visibility. The extent of these effects is not always completely defined; it is abundantly clear, however, that the problem is real and solutions are needed now.

Several characteristics of the total problem suggest that dealing with it adequately will tax our capabilities. First, the projected growth rate of SO_2 emissions, based on anticipated demands on the industries producing sulfur oxides pollution, calls for fast solutions. Even if methods for control are developed and applied at the fastest possible rate, emissions of sulfur oxides across the Nation will increase substantially in the year just ahead.

There are, of course, several methods for reducing SO_2 concentrations in urban areas that are available today. Important contributions to the solution of present problems can be made by fuel substitution, e.g., use of natural gas instead of coal or residual oil or selection of the low-sulfur coal or oil available; the use of tall stacks to provide increased dilution can be a practical answer in some situations; locating powerplants remote from urban centers can reduce the importance of their sulfur contribution; the use of optimum known coal-cleaning methods such as simple washing will remove a portion of the sulfur of many coals. These can make important contributions to the reduction of ambient air concentrations of sulfur oxides and they should be promoted; however, they are limited solutions and will not be adequate for future pollution problems. We must, therefore, develop means of control of pollution at the source. This will require a number of new control techniques, each of which is tailored to the technical demands of the individual sources of sulfur oxides. Finally, in dealing with sulfur oxide pollution we are working within a framework of severe economic limitations—limitations that vary with geography, plant size, and a host of other factors, so that each source represents a unique economic problem. Each of the factors will be discussed further.

We can best illustrate the diversity of technical problems involved in control at the source by considering the various operations that emit sulfur oxides and their estimated contributions, as shown in Table I.[1] The problems entailed in preventing pollution from such diverse sources as smelting, sulfuric acid manufacturing, and combustion processes are vastly different. Consider the variation in such factors as volume of gas to be treated, composition of the gas, its temperature, and similar variables. At first glance, it might appear that the total problem is simplified in that 80 percent of the total pollution results from combustion of fossil fuels. Unfortunately, this is not so; desulfurization of coal involves different problems from those of desulfurization of fuel oil, and removing sulfur oxides from fuel-oil-combustion products is a different problem from removing them from coal-combustion products, where different types of ash are present to poison catalysts, foul reactors, or inhibit reactions of sulfur oxides.

Table I.—*Sulfur dioxide emission to U.S. atmosphere in 1963*

Process	Sulfur dioxide [1]	
	Tons	Percent of total
Combustion of coal:		
Power generation (211,189,000 tons)	9, 580, 000	41. 0
Other combustion (112,630,000 tons)	4, 449, 000	19. 0
Subtotal	14, 029, 000	60. 0
Combustion of petroleum products:		
Residual oil, power generation	650, 600	2. 8
Residual oil, other combustion	3, 052, 000	13. 1
Other petroleum products	[2] 1, 115, 000	4. 8
Subtotal	4, 827, 000	20. 7
Refinery operations	1, 583, 000	6. 8
Smelting of ores	1, 735, 000	7. 4
Coke processing	462, 000	2. 0
Sulfuric acid manufacture	451, 000	1. 9
Coal refuse banks	183, 000	. 8
Refuse incineration	100, 000	. 4
Total	23, 370, 000	100. 0

[1] A small amount of this tonnage is converted to sulfur trioxide and sulfuric acid mist before discharge to the atmosphere.

[2] 10, 000 tons from gas included.

Even when we consider a single class of polluters, the coal-burning power production units, we find that size (which may vary by a factor of 10) and location of the unit are critical in terms of economics; e.g., complex processes capable of serving the large new powerplants are far too costly for use with small, existing plants; similarly, control processes that produce sulfur or sulfuric acid are not economically feasible unless markets for these byproducts are accessible. Consider a large modern plant (1000 mw) burning fuels with the sulfur levels common in present practice (coal with 2½ percent S). Such a plant produces approximately 1.7 million standard cubic feet per minute (scfm) of effluent with 0.20 percent SO_2. Daily emissions of sulfur oxides from such a plant would drop from 410 tons per day to 41 tons per day. But for economical use of a process that produces sulfuric acid as a byproduct, the plant would require nearby markets for over 500 tons per day of acid.

Thus, although combustion processes constitute a major class of sulfur oxides sources, we must deal with many subclasses based on type of fuel, size of plant, location, and age of the unit. The other major sources listed in Table 1 are also fragmented in this way. Thus, we must develop many possible routes to sulfur control to yield a variety of methods that will deal with all aspects of the problem.

PAST WORK OF SULFUR CONTROL

Research to control SO_2 from sources by removal of sulfur oxides from process effluent gases or removal of sulfur from fuels has had a long history. Substantial expenditures have been made, but these have been inadequate in terms of both the urgency of needs and the scope of the problem. Early work consisted mostly of efforts to develop means to recover sulfur as a profit-making venture; e.g., the TVA undertook work to recover sulfur values in flue gas as far back as the 1940's. Other processes were developed to collect SO_2 from smelters, either for sale as SO_2 or for processing to produce sulfuric acid. Removal of sulfur from coal was studied to determine whether high-sulfur coals could be upgraded for use in steel making. Refineries developed means for converting high-sulfur residues into more valuable low-sulfur products. Unfortunately, much of this work is not directly applicable to present problems. The smelter operations, for example, may start from gases containing several percent more of sulfur dioxide and clean them to levels which equal or exceed the starting concentrations in the combustion gases, the biggest problem today. Since about 1960, research goals have been increasingly modified to reflect the needs associated with pollution from sulfur oxides, but the work has continued to be of limited effectiveness because the level of expenditure was far from adequate. The weakness of our present position thus is mostly attributable to our being slow to recognize the seriousness of sulfur oxide pollution. Fortunately, there is now general recognition of the need for intensive and coordinated engineering research on a wide variety of methods for control. Progress in the months ahead should be substantially greater than in the past.

In spite of the diversity in engineering and economic problems associated with individual sources, the processes that have been considered for source control can be categorized into three classes: processes for high-efficiency removal of sulfur dioxide from process effluent streams, processes for removal of sulfur from coal, and processes for removal of sulfur from residual fuel oil. Where cleaning of effluent gases is involved, the treatment of combustion gases from power-generating sources poses the greatest problem, both from the standpoint of total contribution to the pollution problem and from the standpoint of technical problems associated with control. Hence, development of processes for controlling sulfur pollution from fossil-fueled power plants would result in elimination of the largest single source of sulfur pollution. Work to develop such processes would most certainly yield know-how that would also be largely applicable to the small contributors, such as smelters, refineries, and acid plants, where the lower volumes to be treated and higher initial concentrations pose simple problems. For these reasons, past research has been concentrated on means for removing sulfur from coal and residual oil. The following discussion of our present ability to control emissions is presented along the same lines—first, processes for flue gas treatment, then methods for desulfurization of fuels.

DESULFURIZATION OF FLUE GASES

The earliest research specifically directed toward collection of SO_2 from powerplant flue gases was mainly concerned with wet scrubbing processes. Several of these were studied and applied in England; two stations there are now equipped with wet scrubbers that provide high-efficiency collection of sulfur oxides.[2] These processes are not considered a satisfactory solution, however, since cooling of the effluent gases causes them to sink as they leave the chimney so that ground level concentrations near the plant are higher than those that would be experienced if no control device were employed. Wet processes, therefore, were mostly eliminated from consideration, and most research effort has been concentrated on dry processes that allow the gases to leave the process at temperatures high enough to disperse pollutants that remain after gas cleaning. Because of problems experienced in developing dry processes, however, researchers are reexaming such possibilities as wet processes combined with flue-gas reheat. Small-scale process work is under way in France and the United States; so far, no new large-scale work has been announced.

In past research of dry methods for removing sulfur from power-generation flue gases, a number of processes have been demonstrated to have potential for limited application where added costs for sulfur collection can be justified. All of these processes entail serious problems, which must be solved before the processes can be termed economically feasible. We have good reason to believe that these problems can be solved in the coming months through the combined efforts of governmental and industrial groups who are vitally interested in abating pollution by sulfur oxides. We need to study prototypes large enough to generate data that can be used to define the economics of the process and provide information necessary to design full-scale equipment with confidence. Some work on large prototypes is now in its early stages in Germany and Japan. More is in the advanced planning stages in the United States, where three or more processes will be scaled-up under programs sponsored by the Public Health Service and industrial groups. In the discussion that follows we will consider only those "first-generation" flue-gas cleaning processes that are the subject of present plans for scale-up. Time does not permit discussing newer processes, which admittedly may prove ultimately to be superior. It should be added also that the point at which a process can be said to be ready for scale-up is always debatable, and when the processes are judged solely on the basis of published information, attempts to classify them as "ready" or "not ready" for large-scale studies requiring multimillion-dollar investment are especially hazardous. Nevertheless, we will attempt to discuss the potential of those processes that are being offered as the best possibilities for "first-generation" methods for control.

DIRECT CONVERSION OF SULFUR DIOXIDE IN FLUE GAS TO ACID

A process that directly converts sulfur oxides to sulfuric acid by passing the flue gases over a catalyst and then cooling to condense the acid [3] will be operated on large-scale equipment during 1967. The project is being financed jointly by Metropolitan Edison Co. and Monsanto Co. The equipment, which processes 25,000 scfm of gas (5 percent of the total flow from a 250-mw boiler), will cost about $2,500,000 and will be located at Portland Station in Portland, Pennsylvania. Operation is expected to begin in May 1967. The first experimental program is expected to run for about a year. If all technical problems can be solved, the information necessary for commercial design may be available by the end of 1967. This process shows promise of being economically attractive for controlling pollution from large new stations located near the markets for the acid. Process costs have not yet been defined, and the extent to which such a process can compete with other sources of acid remains to be seen.

METAL OXIDE SORPTION

Two processes involving reaction of SO_2 in flue gas with metal oxides are scheduled for large-scale studies. An "alkalized alumina" process [4] has been developed by the Bureau of Mines under a program funded by the Public Health Service and studied on bench-scale and small pilot-scale equipment. During 1967 this process will be investigated on intermediate-scale equipment. When these studies are concluded, design and construction of a larger unit will begin. It is hoped that a prototype unit can be put into operation in 1969 and that the potential of the process can be quantitatively established by 1970 or 1971. The cost and size of this equipment will be comparable to that required for direct conversion. This process, like the direct acid process, can be considered only for large new power stations at which the complex chemical-processing equipment can be justified; alkalized alumina, however, has one advantage in that it produces sulfur, which is the favored byproduct in most locations. Unfortunately, its potential as a break-even process in its present state of development is not good, and its application is likely to increase powerplant costs by at least $1 per ton of fuel.

The other metal oxide process to be scaled-up is a manganese-oxide process being developed by Mitsubishi in Japan. This process would react sulfur dioxide with the powdered manganese oxide, and would produce either gypsum or ammonium sulfate as byproducts. We do not yet know specifically how many of the potential problems have been dealt with, because only a limited amount of information has been released. A scale-up to a unit which will process around 50,000 scfm of flue gas is said to be under way; this suggests that the process should qualify as a "first-generation" solution, but until more information becomes available its potential for application in the United States must be considered questionable.

LIMESTONE-BASED PROCESS

Research on limestone processes for collection of sulfur dioxide is under way in at least nine laboratories in Germany, Japan, and the United States. The widespread interest is inspired by early work, which suggested that relatively inexpensive limestone-derived materials could be injected directly into existing boilers to effect highly efficient collection of the sulfur oxides in the flue gas.[5] The feasibility of such a process is currently in doubt because of conflicting results from outgoing work. Although the existing data are insufficient to permit drawing firm conclusions, it still appears that limestone, calcined limestone, or calcined and hydrated limestone may be inexpensive enough and yet reactive enough for use in a simplified process that provides for direct contact with the flue gas, reaction with sulfur oxides, and discarding of the sulfur-laden calcium compounds along with fly ash collection in conventional equipment. We have not yet enough data to establish whether a special reactor will be required to provide adequate contact between the calcium and the sulfur oxides. Such a process, with or without a reactor, is most attractive because it is one of the few that might be adaptable for control of the smaller new plants. This process has the further potential advantage of being adaptable for use in episode control because its simplicity would allow startup and shutdown on short notice. The cost of either a limestone "injection" or a "reactor" process will depend on the effects of such factors as chemical composition on reactivity of the sorbent and process kinetics. A concerted cooperative effort by several industrial and governmental research groups in the United States is under way. It is hoped that this program will yield data for large-scale evaluation of direct injection by the end of 1967 and for start of construction of prototype reactor systems especially designed for good contact between the sulfurous pollutants and the sorbent material by the end of 1968.

CHAR SORPTION

Char sorption is being evaluated in Germany on large-scale equipment. This work involved a proprietary process[6] for which many details are not available. Here, as with the Japanese manganese oxide process, we lack specifics relative to problems that have been encountered, and thus the potential for this process is difficult to assess. Known difficulties associated with size of equipment, fire hazards associated with oxidation of the char, and related problems indicate that this process in its present form is unlikely to contribute significantly to control of sulfur oxides in the United States. We do not mean to imply that char processes are without long-range potential; the potential is there, but the technical information needed for process design is not available.

PYRITE-COAL COMBUSTION

All processes discussed so far are restricted to use with relatively large combustion units, such as powerplants. Low-sulfur fuels seem to be the only answer for small space-heating and industrial power units. This type of control will be critical in areas such as Chicago, New York, and Philadelphia. Processes that will produce low-sulfur fuel at reasonable cost are therefore needed. One such process that burns the pyrite-coal rejects resulting from coal-cleaning processes is being considered by the Public Health Service. This process would produce heat, sulfuric acid (or sulfur), and possibly iron oxides for blast furnaces. With such a process the cleaning of pyritic sulfur from coal would be much more economical in many situations. Substantial quantities of low-sulfur coal could be made available either for power generation or for use in the small systems that generate steam or heat for commercial or industrial use. There is much to recommend such a process; most of the system components have been developed and proved in a usage similar to that visualized.[7] Because process development work would be minimal, it seems reasonable to expect that a large prototype unit could be in operation by mid-1968. Unfortunately, this process can be applied only in situations where appropriate coals are available.

REMOVAL OF SULFUR FROM FUELS

DESULFURIZATION OF COAL

Sulfur in coal is present in varying amounts in pyritic and organic forms. Unfortunately, the organic sulfur is not amenable to removal by nondestructive methods. Pyritic sulfur, because of differences between its specific gravity and that of coal, can often be separated by use of conventional coal-cleaning equipment. How effectively this can be done depends primarily on how effectively the pyrite can be liberated from associated coal through size reduction and on how effectively the pyrite-bearing particles can be separated from the coal without carrying excessive amounts of coal along with the rejected material. On the surface, the problems associated with separation of pyrite with specific gravity of 5.0 from coal with specific gravity of 1.25 by crushing and applying methods based on the difference in density seem simple. Unfortunately, pyrite is sometimes present in such finely divided particles that such separations are difficult or impossible. Further, the tonnages which must be processed to supply the large modern powerplant are so great that even the cost of routine operations like crushing and washing add substantially to the cost of power produced when there is no return from recovered products. The previously mentioned pyrite-coal combustion process has potential for modifying these economic barriers. Unfortunately, complete information is not available to fully assess the degree of sulfur removal possible by coal-cleaning methods. Data on coal "washability" is almost totally lacking, and even information on the relative amounts of pyritic and organic sulfur in important coals is incomplete.[8] Programs being conducted by the Bureau of Mines, the Public Health Service, Bituminous Coal Research, and some of the State geological surveys should lead to a better understanding of the extent to which we can reduce sulfur pollution by cleaning coals.

DESULFURIZATION OF RESIDUAL FUELS

The residual fuel oil used to produce heat or electric power is the material that remains after the more valuable products such as gasoline and distillate fuels have been removed from the crude oils in refinery operations. The petroleum industry has developed many techniques for converting this material to more valuable products; as a result, modern refinery practice in the United States is resulting in reduced output of residual fuels. The trend to decreasing production of residual fuels in the United States refineries is causing increased use of imported residual oils, which are generally higher in sulfur than domestic varieties; thus this trend will aggravate rather than alleviate the pollution problem. Reductions of sulfur in residual oils can be accomplished by hydrogen treatments (hydrodesulfurization) of the crude oil or by blending desulfurized cutter stocks with the very heavy residuum to produce residual oil or by hydrogen treatment of the residual oil itself. The cost of producing low-sulfur fuel by these methods varies with such factors as sulfur content of the crude oil, type of crude, refinery size, demand for other petroleum production, and cost of hydrogen. It is expected that sulfur removal will add $0.25 to $1.00 a barrel (10 percent to 40 percent) to the cost of residual oil.[9] Because of the importance of these costs in power generation and because of the increasing need for low-sulfur fuels, development of new methods is highly desirable. Such work is under way in the petroleum industry, but published literature gives no indication that a new process capable of greatly reducing sulfur pollution is near to being a commercial reality.

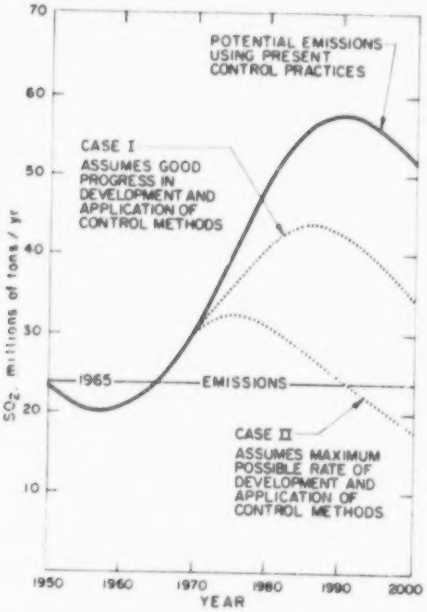

FIGURE 1. Potential sulfur dioxide emissions in the United States.

FUTURE PROSPECTS

Future emissions of sulfur oxide were the subject of a recent study.[10] Estimated demands on the industries producing sulfur-oxide pollution were used to project the overall emission rates to be expected under varying degrees of control of emissions. Figure 1 shows an estimate of what can be expected at two levels of control as compared with present practices: (1) with good progress in development and application of control methods (Case I), and (2) with control methods developed and applied on a "crash" basis (Case II). We recognize that overall national emission rates should not be applied indiscriminately for estimating future local emission levels, which may increase faster or slower than the national average; however, they do indicate the general magnitude of future problems that will arise unless methods for control of pollution at the source are developed now.

Because increase in demand for products seems inevitable, the prospects for control of ambient concentrations will depend primarily on our progress in developing and applying new processes for sulfur oxide control. Thus the future can be discussed only in terms of the prospects for success of the needed work. What our status will be in the years ahead with respect to the curves of Figure 1 will depend on our success with programs just now being developed. Forecasting under such circumstances is particularly hazardous, and becomes more uncertain as the period of our forecast lengthens. With these thoughts firmly in mind, we will nevertheless attempt to look ahead.

For the immediate future (say, until 1975) primary needs are: (1) to promote increased application of methods presently available for control of SO_x, and (2) to develop "first-generation" processes to assure that methods are available for control of as many of the different sources of sulfur-oxide pollution as possible. The broadest program now under way is that of the Public Health Service. The alkalized alumina process will be developed as far as possible for application to the large new power stations. Limestone-based processes will be developed for the new and existing plants in the intermediate size-range, and the pyrite-coal combustion process is being considered for its potential for providing low-sulfur coal for any process. Additional projects sponsored by industry will provide some solutions. The Monsanto-Metropolitan Edison direct-acid process is also potentially applicable to the large new plants. Work by Bituminous Coal Research on removal of pyritic sulfur should lead to methods that will at least minimize emissions from powerplants where "cleanable" coals are available. We hope too that some of the proprietary work in the petroleum industry will lead to development of new techniques for producing quantities of low-sulfur residual fuels at reasonable prices. These programs are in early stages but support of research and development of the Federal government has increased recently and interest in industry is growing rapidly. It appears that we have begun support at increased levels which, if continued, should provide the relief needed for the critical years between now and about 1980. It seems reasonable, therefore, to expect that technological advancement will allow emissions in this period to fall along the curve depicted by Case I provided applications of such methods are adopted. Note that with even this degree of success sulfur oxides emissions nationally will about double. To effect a higher rate of control would require an extensive effort, the ultimate of which is depicted by Case II. Even in this case emissions will increase by 50 percent over present levels.

In the years ahead, competitive pressures from nonpolluting industries (e.g., atomic power) and public pressure for clean air at minimum expense will result in a need to replace "first-generation" processes now being developed with more economical processes. Therefore we should be working now to develop such "second-generation" processes if we hope to provide better means for control in the period from 1975 to 1980. Second-generation processes would incorporate totally new concepts, eliminating the factors that limit the economic capacities of first-generation processes. The type of process visualized can be illustrated by one process now under consideration. A molten mixture of salts would be reacted with SO_2 to form sulfites in a scrubber operated at 800 to 900° F. The good mass transfer of a liquid-gas system coupled with high reaction rates at elevated temperatures are expected to provide great advantages over processes employing the large low-temperature solid-gas reactors that constitute an important cost item in many first-generation processes. Admittedly, development of any process based on new concepts would require the solution of many technical problems. Meeting time schedules in application of such processes is further complicated by the need to generate firm design specifications as early as five years before the plant is to be put into operation. Present national interest in abating pollution and recognition of the deficiencies of most first-generation processes have inspired considerable new thinking which, if given proper support now, can lead to better processes toward the close of the 1970's.

Prospects beyond the critical period, which will probably peak in the years from 1980 to 1990, become exceedingly hazy. Many important factors, such as the rate of application of nuclear energy, cannot be estimated with any certainty. The competitiveness of fossil fuels in this period will probably be determined by success in development of new power cycles that combine sulfur collection and power production in integrated high-efficiency, low-pollution systems. Such systems are just now beginning to receive serious consideration. At this point, chances of successful developments in this area are somewhat speculative, but it seems certain that such developments will weigh heavily in the proportion of the power-generating market captured by atomic energy. Further, it is probable that the advent of nuclear power, combined with development of new methods in all areas, will halt the increase of emissions in the 1980–90 period, with reduction when older plants are replaced with units having a greater degree of control. Note, however, that the elimination of sulfur pollution completely is a goal that does not appear to be technologically or economically consonant with an increasing population coupled with an expanding economy and increased standards of living. A reasonable projection into the future indicates that it will be beyond the year 2000 before levels are again reduced to what they are at the present time.

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REDUCTION IN AMBIENT AIR CONCENTRATION OF FLY ASH—PRESENT AND FUTURE PROSPECTS

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In discussing the present and future prospects for reduction of fly ash from heat and power generation, we are, by definition, talking about emission from the combustion of fossil fuels utilized for generation of electric power in industrial and utility systems; for generation of industrial process steam; and for commercial and residential space heating.

Although fossil fuels, or their derivatives, are utilized in the generation of thermal energy for transportation—an area of growing importance in the solution of the air pollution problems—I think we can exclude this from our consideration here for it is being covered adequately in another session as a separate and distinct problem.

As we all know, energy sources for heat and power generation, as above defined, can be broken down into five categories: coal, oil, gas, hydro, and nuclear. We can immediately exclude hydro and, from the standpoint of total mass of particulate emission to the atmosphere, we can also exclude nuclear and gas. Our attention is thus confined to the combustion of oil and coal for generation of electric power, process steam and space heating.

Heller[1] has presented projections on utilization of coal and oil for the categories of interest to us—namely, utility, industrial and commercial-residential—which show an increase of 55 percent in coal utilization and an increase of 22 percent in oil utilization in the period 1960–1980. These are shown in Table I together with projections back to 1940 on the basis of the rate of increase of installed utility capacity and reduction in heat rates according to Reid.[2] They are in general agreement with projections from other sources.[2, 3, 4] They are based upon approximately 32 percent of the new utility capacity operational between now and 1980, and 86 percent of the new operational capacity between 1980 and 2000, going nuclear.

There are recent indications that the penetration of nuclear power is going much faster than this (68 percent of new capacity operational by 1971 to be nuclear.)[12] If such will be the case, then our projected emissions from utility boilers and stacks are admittedly high, but we feel the conservative view is appropriate in setting goals.

Distribution of coal-firing methods and emissions factors for the various coal-firing

TABLE I.—*Estimated energy consumption* BTU × 10^{15} *per year*

	1940		1960		1980		2000	
	Oil	Coal	Oil	Coal	Oil	Coal	Oil	Coal
Electric utilities	0. 17	1. 78	0. 64	4. 99	0. 79	9. 77	0. 86	10. 95
Industrial heat and power	1. 4	1. 75	1. 96	1. 93	3. 01	2. 20	5. 70	2. 71
Residential and commercial space heating	3. 6	2. 2	3. 83	1. 13	4. 07	. 52	4. 75	. 20
Total	5. 17	5. 73	6. 43	8. 05	7. 87	12. 49	11. 31	13. 86

methods, as well as those for oil, are shown in Table II.

From the foregoing information, we can construct a general picture on the past and future prospects of fly ash emission from the various source categories before making any reductions in the figures because of particulate collection equipment. Total generation of fly ash from all fossil fuel sources—before any collection—is expected to increase from 1960 levels of about 20 million tons per year to about 32 million tons per year in 1980, and 36 million tons in 2000. This is shown in Table III and Figure 1.

Let us now examine the past custom and present status of collection of these emissions in an attempt to establish where we stand today on total emission to the atmosphere, and to establish the demands of the future for holding these emissions to present levels—or even reducing them—in the face of increasing use of fossil fuels. Since almost 75 percent of the fly ash generated in the next 40 years will be from utility boilers, let us begin there.

Collection of fly ash from utility boilers over the years has been accomplished with relatively inefficient settling chambers and cinder traps (20 percent efficiency), cyclones and multicyclones (70 percent average efficiency), and electrostatic precipitators with efficiencies ranging from 85 to over 99 percent. Based upon the data presented by Landers,[7] together with our own statistics on the distribution of efficiencies of electrostatic precipitators over the period 1940–1966, we know the general efficiency distribution of newly-installed fly ash collection equipment on utility boilers is essentially as shown in Figure 2.

TABLE IIA.—*1960–2000 distribution of firing practice* [1] *and boiler emission factors for coal* [2]

	Distribution percent	Emission factor, number, per 10^6 B.t.u.
Utility:		
Pulverized	90	5. 5
Stoker	0	6. 2
Cyclone	[3] 10	1. 0
Industrial:		
Pulverized	20	5. 5
Stoker	70	6. 2
Cyclone	[3] 10	1. 0
Residential and commercial:		
Pulverized	0	
Stoker	100	3. 5
Cyclone	0	

[1] ABMA Statistics 1962–65.

[2] See reference 5.

[3] O in 1940, replaced by pulverized coal.

Today's total fly ash emission from coal-fired utility boilers is the sum of emissions from units of varying ages, with dust collectors of varying efficiency, going back to pre-1940 installations. About 3 percent of the coal utilized for heat and power today is burned in boilers of pre-1940 vintage with over-all dust collection of 40 percent; about 39 percent of the coal utilized is burned in

TABLE IIB.—*Boiler emission factors for oil,*[1] *number per* 10^6 BTU

Utility	0. 055
Industrial	. 055
Residential and commercial	. 083

[1] See reference 6.

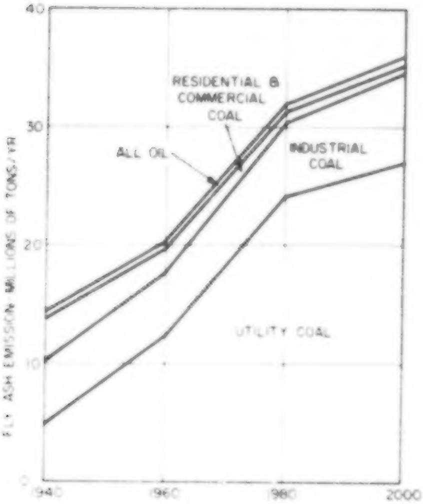

FIGURE 1. Present and projected fly ash emissions from fossil fuel fired heat and power generators before collection equipment.

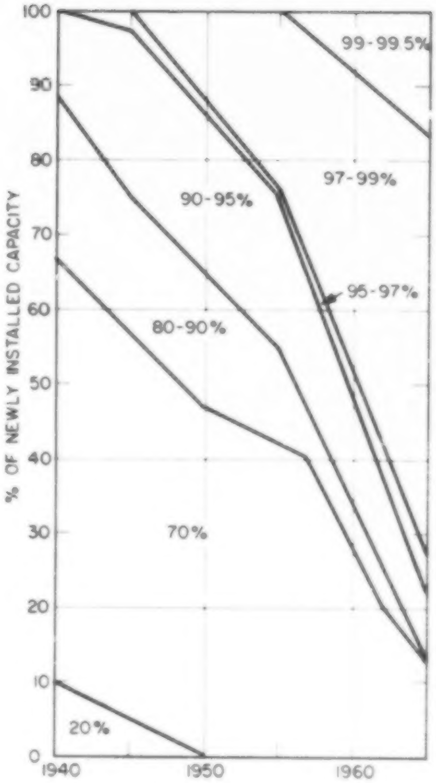

FIGURE 2. Distribution of fly ash collector efficiency according to year of installation.

1960–1965 vintage equipment with dust collection capability of 93 percent.

Table IV is a summary of the percentage of today's total coal utilization in utility boilers carried by equipment in various age categories, together with the total boiler emission, dust collector efficiency and stack emission associated with each age group. These estimates take into account the reduction in average heat rate from about 16,000 Btu/kwh in 1940 to present average levels of about 10,500 Btu/kwh; the reduced utilization of the older units by virtue of their retirement and progressive relegation to peaking service (100 percent fuel utilization for 1965 units down to 20 percent utilization for units 25 years old); and the distribution of dust collector efficiency shown in Figure 2.

Table IV is todays' picture on total emission to the atmosphere from utility boilers—about 2.5 million tons per year. It is interesting to note that although only about 6 percent of the fuel used today is consumed in boilers 20 or more years old, these units contribute almost 20 percent of today's stack emissions. Accelerated retirement, or upgrading of dust collector efficiency of these older units is thus an important factor in the reduction of total fly ash emissions to the atmosphere.

Compared with the foregoing information available on utility boilers, there is very meager information on industrial boilers. We do know that about two-thirds of the coal utilization in industrial boilers occurs in stokers and the remainder in pulverized coal and cyclone furnace units. (See Table II.) Best estimates indicate that half of the stokers are equipped with mechanical collectors performing at approximately 90 percent and half with cinder traps or no collectors at all—at an average efficiency of 20 percent.

There are essentially no electrostatics on stoker-fired boilers. On pulverized coal industrial boilers, best estimates indicate that three-fourths are equipped with mechanical collectors at 70 percent efficiency and one-fourth with electrostatics at an average efficiency of 92 percent. On this basis, 1965 stack emission from industrial boilers is estimated at 1.7 million tons per year from stokers and 0.45 million tons per year from PC and cyclone units, for a total of 2.15 million tons per year.

Finally, considering residential and commercial use of coal, we can state with little error that essentially no dust collection equipment is used in this type of installation, so that boiler emissions are the same as stack emissions, at approximately 1.7 million tons per year.

Oil firing in utilities contributes only about 1 percent to the total boiler particulate emission and this percentage is expected to decrease. (See Table III.) Its contribution to overall particulate emission is thus essentially negligible. Even in the case of industrial, residential and commercial use of oil for heat and power generation—where it is proportionately much greater than for utilities—the contribution to boiler particulate emissions is only about 3 percent and it is not expected to go much above this value.

Particulate collectors are essentially nonexistent on oil-fired boilers. It is true that there is some use of mechanical collectors for reduction of emission during periods of soot blowing where emissions may increase by a factor of four times normal emissions. But this use of collectors is primarily for elimination of nuisance rather than reduction of overall ambient concentration of particulates in the atmosphere.

Thus, from a particulate emission standpoint, oil-fired boilers contribute little to the total emission. Emissions from all oil-firing—utility, industrial, residential, and commercial—total about 0.24 million tons per year and this represents less than 4 percent of the total fly ash emissions from heat and power generation.

The situation on particulate emissions to the atmosphere from heat and power generation in 1965 is as follows:

	Million tons
From utility coal	2.43
From industrial coal	2.17
From residential and commercial coal	1.71
From all oil	.24
Total	6.55

TABLE III—*Particulate emission from heat and power generation before collection*

[Millions of tons per year]

Source	Type firing	Particulate emission			
		1940	1960	1980	2000
Utilities	Pulverized coal	4.9	12.35	24.20	27.1
	Stoker coal				
	Cyclone coal		.25	.49	.55
	Oil	.005	.018	.022	.024
Industrial	Pulverized coal	1.43	1.87	2.12	2.61
	Stoker coal	3.80	3.60	4.09	5.05
	Cyclone coal		.05	.06	.07
	Oil	.038	.054	.083	.157
Residential and commercial	Pulverized coal				
	Stoker coal	3.85	1.98	.91	.35
	Cyclone coal				
	Oil	.150	.159	.169	.197
Total		14.173	20.331	32.144	36.108

Table IV.—*Fuel utilization, boiler emission, collector efficiency, and stack emission in 1965 for various equipment age groups*

Year installed	Fuel utilization, percent total	Boiler emission, 10^6 tons per year	Overall dust collection efficiency, percent	Stack emission, 10^6 tons per year
Pre-1940	3.0	0.54	40	0.330
1940–44	3.2	.58	77	.133
1945–49	0.2	1.83	80	.366
1950–54	18.4	3.32	83.5	.545
1955–59	26.2	4.71	88	.567
1960–65	39.0	7.02	93	.492
Total	100.0	18.0	......	2.433

The overall picture is shown in Figure 3.

A number of interesting conclusions may be drawn:

1. As previously indicated, oil-firing contributes relatively little (less than 4 percent) to overall ambient concentration of particulates. It has been, and will remain, essentially a nuisance problem as far as particulates go.
2. Particulate emissions from industrial use of coal are almost as great as those from utilities. In terms of fuel utilization, stack emissions from industrial boilers are almost three times greater than emissions from utility boilers. In the light of the usual emphasis placed on utility boilers, this fact seems somewhat surprising and suggests that increased attention to reduction of emissions from industrial boilers might yield significant results.
3. The contribution of particulates to the atmosphere from residential and commercial use of coal is still, even in 1965, apparently substantial, even though the total coal utilization for this type of service is only about 10 percent. The answer, of course, is that essentially no collection of fly ash is practiced in these small units.

Looking to the future, the problem of holding the line or reducing particulate emissions from heat and power generation is primarily a question of the anticipated technological capability for dust collection and the actual use of this technological capability. It is primarily a problem of collection because no significant new developments which offer promise for reduction of emission by changes in firing practice are visible on the technological horizon (except, of course, alternate fuel sources such as nuclear, which has already been taken into account in projected fuel utilization).

There is no question that the boiler emissions resulting from the use of fossil fuels for heat and power generation are going to increase substantially—even in the face of nuclear power—and our only tool appears to be improved collection.

The technological capability to collect fly ash has shown a consistent trend upward from 96 percent in 1940 to 99.5 percent in 1964. We define technological capability as the commercial availability of fly ash collection equipment—guaranteed on a day-to-

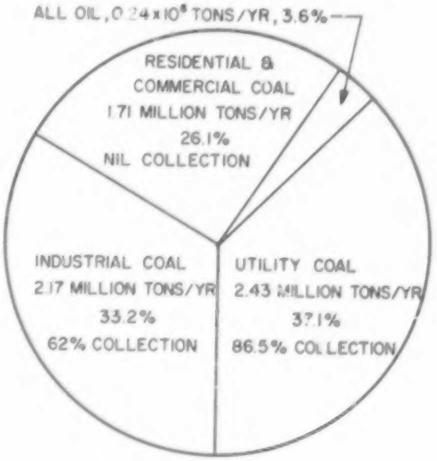

Figure 3. Amount and distribution of fly ash emission to the atmosphere from heat and power generation—1965.

day basis and irrespective of type. There is every reason to expect that the trend in technological capability will continue—with the expectation that we will have a 99.9 percent capability in the decades following 1980. This expectation is based upon continuing fundamental research in electrostatic precipitation focused particularly on the collection efficiency region above 99 percent; it is based upon our experience with precipitators in other applications where levels above 99 percent are routinely obtained; it is based upon the possible utilization on fossil fuel-fired boilers of fabric filters, with their inherently high collection capability; and it is based upon the potential impact of ultrahigh fly ash collection requirements of flue-gas desulfurization or solid fuel-fired gas turbine systems.

The actual use of fly ash collection equipment has lagged far behind the technological capability. In 1940, when we had the capability for 96 percent collection, the actual capacity weighted average collection efficiency of newly installed fly ash collectors of all types was only about 75 percent.

Even today, when we have a capability of 99.5 percent, the overall average collection capability of equipment just now going into operation is only 95.5 percent. Today, even though we have the capability to go to 99.5 percent, only 15 percent of the new generating capacity on order which will go into service by 1968–1970, is being equipped with collectors above 99 percent.

However, actual installation of new equipment has been converging on technological capability. The utility industry, in particular, has often been cited for its leadership in improved collection of fly ash. Here is tangible evidence of that leadership. Over the period 1940 to 1965, the gap in utilities has been closed substantially. Average efficiency of newly installed collection capacity has been raised from 70 percent to over 95 percent and equipment being planned for now, which will be going into service in 1970, will further raise this to almost 99 percent.

This closing of the gap has been brought about primarily by the virtual elimination of mechanical collectors of all types on utility boilers in favor of electrostatic precipitators or combination mechanical collector-electrostatic precipitator installations in the 97 percent to 99 percent plus range.

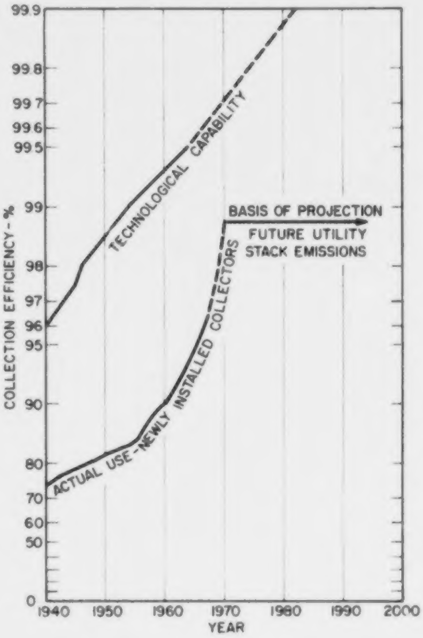

Figure 4. Growth in efficiency level of fly ash collectors—capability versus actual use.

This past history on the growth of dust collection efficiency capability on utility boilers, together with past history of actual use of this capability, is shown graphically in Figure 4.

The future outlook on particulate emission to the atmosphere from coal-fired steam generators depends on two main factors: The efficiency levels specified for new capacity being installed, and the rate of retirement of upgrading of existing capacity. For the utility boiler case, we know that the average efficiency of collectors being specified today, for units that will be in service in the next two to three years, is in the range of 98.2 percent to 98.8 percent, and that there is every expectation that this efficiency level on new equipment will continue or be increased. We also expect, based on FPC studies,[3] that the most probable retirement or upgrading practice in the future will be based upon retirement at 30 to 35 years. Assuming fuel utilization factors linearly declining from 100 percent at 0 years to 0 percent at 32 years, projections on overall collection

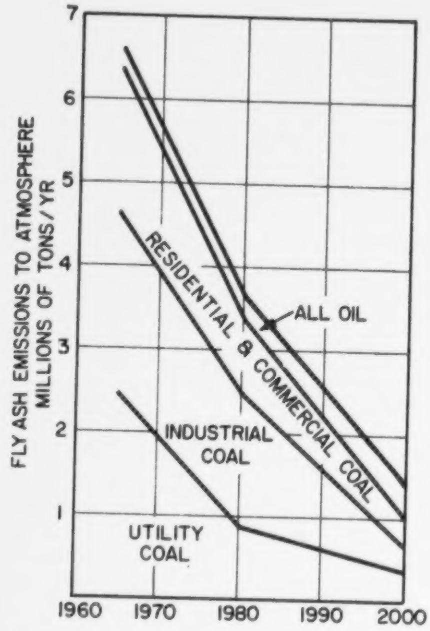

FIGURE 5. Projected amount and distribution of fly ash emission to the atmosphere from heat and power generation—1965 to 2000.

efficiency and stack emissions from utilities in the next 30 to 35 years indicate a substantial decline in spite of the anticipated increase in total coal utilization and boiler emissions.

Even assuming no increase in overall efficiency of newly installed capacity above 98.8 percent, the expected stack emissions in 1980 and 2000 are estimated at 0.82 and 0.33 million tons per year respectively, compared to present day levels of 2.43 million tons per year. (See Figure 5.) Because of the substantial amount of background data available, we can make these predictions with reasonable certainty.

For the industrial boiler case, the situation is not quite so clear, primarily because accurate data on retirement practice and efficiency specifications on new installations are not presently available. Industrial concerns will either be forced by legislative pressure to conform to quantitative emission criteria or they will follow utilities which are going beyond any existing or foreseeable quantitative emission codes in their quest for clean looking stacks.

Equipment now being used in new operating utility plants and being ordered for future utility plants will give stack emissions of only about one-fourth to one-fifth those required by present PHS criteria governing new Federal facilities and buildings,[8] which criteria have been proposed as an exemplary model for future State and municipal codes.

The most probable expectation is that the industrial concerns will, in fact, increasingly adopt the utility philosophy and shoot for the psychologically desirable objective of clean looking stacks. If we make this assumption, and assume also a retirement practice similar to utilities (30 to 35 years), and take into account the more favorable optical extinction properties of the smaller stacks on the smaller industrial boilers—we can expect fly ash emissions from industrial boilers to drop to about 0.33 million tons by the year 2000.

With respect to residential and commercial use of coal and all use of oil, projected changes in fuel use patterns indicate an automatic decline. Even in the absence of any substantial collection of fly ash from these sources—a pattern which is expected to continue—we can look to a reduction in emissions by virtue of reduced use of fly ash producing fuels in this service.

The overall outlook for fly ash emissions to the atmosphere is shown in Figure 5. Comparing these projections with those of Heller,[1] we find a more drastic reduction in fly ash in the next 35 years, primarily because utilities are going well beyond any present or anticipated quantitative emission codes in their quest for stacks optically clear of particulates, and because industrial concerns will follow their lead.

The outlook thus appears to be somewhat brighter than has been proposed heretofore. We should expect total fly ash emission levels to drop from present-day levels of about 6.5 million tons per year to about 3.6 million tons by 1980, and to about 1.4 million tons by 2000. It is interesting to note also that the various source categories probably will be contributing an equal share of the overall emission to the atmosphere.

Probably more important than the gross projections has been a clearer definition of criteria which must be adhered to if we take the foregoing projections as national goals for reduction of ambient fly ash concentrations. These may be stated as follows:

1. *For Coal-Fired Utility Boilers (100 MW or more)*
    - (a) All new capacity should be equipped with fly ash collectors of 99 percent minimum capability.
    - (b) Units older than 30 years should be retired.
2. *For Coal-Fired Industrial Boilers (less than 100 MW)*
    - (a) All new capacity should be equipped with fly ash collectors of the following minimum efficiency dependent upon firing practice: *Stokers*—96 percent; *Pulverized Coal*—98 percent; *Cyclone Furnace*—90–98 percent depending on ash reinjection practice.
    - (b) Units older than 30 years should be retired, converted to oil or gas, or equipped with fly ash collectors with above capability.

A final word about costs to achieve these goals. Although there are many factors involved, such as size of installation, escalating labor and material costs, etc., in addition to performance level, we can make some reasonably accurate generalizations which should serve to bring the economics into focus.

Total cost of fly ash collection equipment for 99 percent efficiency, installed with associated ash removal piping, but not including foundations, supporting steel, and flues, is approximately $2.30 per kw of plant capacity in units of 100 megawatt size, down to about $1.46/kw for units of 1000 megawatt size. Labor costs and fuel condition might cause this number to vary by a factor of as much as two. These represent about 2.3 percent and 1.97 percent respectively, of the total plant cost.[10]

Projections on typical pooled utility unit sizes in the 1970–1980 decade,[11] indicate an average size unit of about 700 megawatt where collector installed costs would run about $1.61/kw, about 2.03 percent of the total plant cost of $80/kw. (It is interesting to note that the dollar investment per kilowatt for 99 percent collection today is no more, and in most cases, less than the investment per kilowatt ten years ago for collectors only 97 percent efficient, in spite of rising labor and materials cost. This is due not only to increase in average unit size and reduction in heat rate, but to cost reduction effected by the collector equipment suppliers).

Based upon projected utility capacity increases for coal-fired steam generators—about 120,000 mw in 1970–1980 and 72,000 in 1980–2000—the bill for fly ash collection equipment in utilities between now and 1980 will total about $315 million; $195 million to be spent between now and 1980 and $120 million between 1980 and 2000.

Utilities are presently spending about $25 to $30 million per year for fly ash collection equipment; this is expected to decline to something less than $6 million per year by 2000 as nuclear power assumes the major load carrying position. This is the pattern already established in the utility industry—and a pattern which will continue with very little incremental investment per kilowatt of installed fossil fuel-fired capacity over what has been the practice in the last few years.

Such is not the case with industrial use of coal-fired steam generators. Estimates of present practice on industrial boilers indicate an over-all investment of slightly less than 0.5 percent of the total plant cost for fly ash collection equipment which performs at an average collection efficiency of 62 percent.

To achieve the overall 95 percent collection necessary to meet the goals for reduction of fly ash emission to the atmosphere just presented, this investment will have to be raised to something in the order of $0.52/kw for the two-thirds of capacity fired with stokers and $3.78/kw for the remaining third of capacity fired with PC or cyclone furnaces.

The overall average investment will thus be about $1.63/kw or about 1.25 percent of total plant investment. Based upon an expected 35 percent growth in demand for industrial steam and power between now and 2000, and retirement practice at 30 to 35 years, this will mean an expenditure in the next 34 years for fly ash collection of about $77 million.

Thus, the overall bill in the next 34 years, to reach a goal of about one-fifth of today's fly ash emission to the atmosphere, is going to be about $400 million. This is an average of a little over $11 million per year and can hardly be considered a tremendous cost. It amounts to about 5 cents a year per capita, and under very adverse conditions, i.e., labor costs, low sulfur fuel, etc., would amount to only 10 cents per year.

Secretary John Gardner has been quoted as stating,[9] "Many groups have raised the specter of tremendous costs for air pollution control. If this is a fact, we need to know it. If it means our technology must improve, we need to know it. But if it is merely a specter, then we should exorcize the ghost at this time."

We hope we have conveyed the fact that reduction of fly ash emission to the atmosphere from heat and power generation is well within our present technology. We hope also that we have made some headway in casting out the evil spirit of tremendous costs.

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". . . research scientist in coal combustion . . . former university instructor and industrial chemist . . . developed testing methods and analytical techniques in combustion chemistry, corrosion and air pollution . . ."

REDUCTION OF EMISSION OF OXIDES OF NITROGEN—PRESENT AND FUTURE PROSPECTS

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In 1958, at the First National Conference on Air Pollution, oxides of nitrogen were merely mentioned as having been identified as possibly contributing to the air pollution problem in certain west coast areas. Again, in 1962, at the Second National Conference, in his presentation on "Air Pollution from Power Plants and its Control," T. T. Frankenberg of American Electric Power included a little more, but still a brief comment, concerning further developments in the study of nitrogen oxides and their contribution to air pollution.

This year the subject has its own place on the program. From this, one would assume that during the past eight years there have been sufficient developments to justify separate coverage. It would be gratifying if this were the case. However, research aimed specifically at the causes, effects, and methods for reduction of emission of oxides of nitrogen has not enjoyed the same degree of attention as has that involving the areas covered by the preceding speakers.

Nevertheless, oxides of nitrogen remain among the gaseous components emitted from heat and power generation equipment and should certainly not be ignored in the overall evaluation of air pollution abatement.

Any combustion process which produces high temperatures in the presence of atmospheric nitrogen and oxygen will yield oxides of nitrogen as a combustion product. This occurs not only in the combustion of fuels in heat and power generation equipment, but also in the internal combustion engine. Modern boilers, be they fired with gas, oil, or coal, are designed for high heat release rates and rapid and efficient absorption of the heat released. Both of these features enhance the formation of nitrogen oxides.

Of the several oxides of nitrogen which can occur, nitric oxide (NO) and nitrogen dioxide (NO_2) or its equilibrium product, nitrogen tetroxide (N_2O_4) are considered to be of significance in their contribution to air pollution. In the early 1950's, Haagen-Smit and his colleagues reported on work which established the role played by nitrogen dioxide in the photochemical formation of eye-irritating smog in the Los Angeles basin. Several subsequent workers supported their findings.

In brief, nitrogen dioxide in the atmosphere undergoes photolysis, yielding nitric oxide and atomic oxygen. Atomic oxygen reacts with molecular oxygen to form ozone, while the nitric oxide can react with hydrocarbon radicals in polluted air to reform nitrogen dioxide. The cycle can then repeat, with a relatively small concentration of nitrogen dioxide triggering the formation of a much larger concentration of ozone and oxidized hydrocarbons.

The effects of concentrations of nitrogen dioxide in the atmosphere over the Los Angeles basin having been established, information was sought concerning the sources of the compound. Here began a series of frustrations which have since plagued the scientist and engineer working toward control of air pollution from power generation sources. These sources, although they were not the major contributors to the total nitrogen-oxide content of the atmosphere, were nevertheless contributors. In the conference literature, there is a fresh-off-the-press pamphlet showing the sources of various emissions, and you will find that heat- and power-generating equipment emit approximately 25 percent on a tons-per-year basis of the total oxides of nitrogen that are emitted into the atmosphere. The frustrating thing about the emissions from power-generation equipment was that their contribution resulted from the fact that they were being operated according to the best modern boiler operating practices.

Over the past years, various surveys reveal that emission of nitrogen oxides, and more specifically, nitric oxide, from combustion equipment stacks can vary from less than 100 parts per million to more than 1500 parts per million. The concentrations are affected by maximum temperatures and rate of cooling of the combustion gases, by the load carried on the equipment, by furnace design and combination conditions, and, to a lesser extent, by the type of fuel burned.

During the latter part of the 1950's, some research was conducted to find a way to lower the nitrogen oxide emission from power boilers in the Los Angeles area. Without a target, such as an acceptable emission level, the driving force behind the research seemed to be more a matter of one boiler manufacturer trying to reduce the emission from his equipment to a point equal to, or lower than, that claimed by his competitor.

A method of operation, known by such terms as "controlled combustion," "two-stage combustion," or "staged combusion," developed from this brief period of activity. Achieved by several different mechanical means, the method generally comprises a reduction in the amount of combustion air introduced at the burner, with the balance of air necessary to complete combustion supplied somewhere outside the burner proper.

Use of the method resulted in a reduction of as much as 40 percent in the nitrogen oxide emission from oil and gas-fired boilers.

PRESENT CONTROL METHODS

Specific control methods for the limitation of nitrogen oxides emission from stationary combustion equipment are now essentially those which resulted from the activity in the late 1950's. Some 22 power boilers, all of which happened to be in the State of California, are designed for "staged combustion" to reduce nitric oxide emission. However, several of these are being operated normally, without the benefit of this special equipment, because the normal emission levels are considered "acceptable." At this stage of the game, acceptability is somewhat arbitrary, and is determined, more or less, on a comparison with emission levels from other boilers.

CURRENT RESEARCH

Because of the present emphasis on control of particulate and sulfur oxide emissions—and this is somewhat out of proportion, I would think, to the relative levels of emission of these two—applied research on the reduction of nitrogen oxide emission, per se, is practically nonexistent. However, there is one compensating aspect.

A coincidental reduction in nitrogen oxide emission may well occur as a result of technological developments which have other goals. Ground-level concentrations of the oxides of nitrogen will be reduced, along with those of particulates and sulfur oxides, by the use of high stacks. Maynard Smith has demonstrated what is being done with high stacks.

There is evidence that combustion with low excess-air, a technique that is being sought for benefits not directly associated with air pollution control, will also reduce nitrogen oxide formation and ultimate emission. Flue gas recirculation, another method of operating a combustion unit, is reported to have varying effects insofar as its effect on nitrogen oxide formation is concerned, but there is promise that some reduction will result from wider use of this operational method. High temperature combustion using oxygen instead of air would do much to reduce formation of oxides of nitrogen, since data indicate that the nitrogen content of most ordinary fuels is not the prime source of the oxides.

I cannot overlook the possibility that there are alternative methods of utilization of fuels for power generation which may change this picture of nitrogen oxide formation appreciably.

Current methods under investigation for the removal of sulfur dioxide from flue gases by absorption or adsorption techniques, and by some of the other techniques that Paul Spaite suggested, may also have a marked effect on the oxides of nitrogen present in these same gases.

It might be well to suggest that those doing research on the various sulfur oxide control methods accumulate data on nitrogen oxide levels also. Such data would be very valuable in assessing the need for more specific nitrogen oxide research.

FUTURE RESEARCH

The chemistry of the oxides of nitrogen is well known. Formation of the oxide can be suppressed by lowering peak flame temperatures. This has been demonstrated by slowing the combustion process or by the introduction of steam into the combustion flame.

By slow cooling, nitric oxide formed at high temperature will undergo normal decomposition. Catalytic decomposition can be effected by the use of a variety of surface active catalysts. Catalytic reduction of the oxide to molecular nitrogen can be accomplished by the use of such reducing agents as hydrogen, carbon monoxide, or ammonia. This is the known chemistry. There is no mystery about it.

Application of the known chemistry to the specific problem of the control of nitrogen oxide emission is, at the present time, moving slowly. The incentive for accelerated applied research may have to come from a better definition of how much nitrogen oxide is too much.

It is important to know at what level oxides of nitrogen in the atmosphere become harmful. Because air pollution control is a complex interdisciplinary problem, which includes the elements of public welfare, technical feasibility, and economic justification, satisfactory criteria must be developed. As recently as the congressional hearings on the adequacy of technology for air pollution abatement, held this past summer, expert witnesses expressed the opinion that as yet no such satisfactory criteria exist.

There is need for more research to determine whether oxides of nitrogen do indeed play a major role in the air pollution problems in areas of the country other than the Los Angeles basin. The unusual combination of meteorological conditions and terrain features that exist there, along with optimum concentrations of other pollutants, may make that area somewhat unique for nitrogen oxide participation.

Data must be sought to help establish acceptable ground level concentrations. National Air Sampling Network measurements in six major U.S. cities showed a maximum 24-hour level of 0.2 parts per million during the period between January and June, 1961. The "first alert" level established by the Los Angeles County Air Pollution Control District in its Regulation VII is 3 parts per million. Which of these best represents the target at which control measures should be aimed?

Realize, please, that I am asking for criteria and not regulations. We have to know what we're trying to do. I put myself in the place not of a man associated with the coal business, but a man who is asked to design an engine to supply the rocket power to carry a capsule into moon orbit. I would be very frustrated if I did not know the weight of the capsule or the distance to the moon.

At the same time, better means must be found to evaluate the contribution that heat and power generation equipment make to ground level concentration. Although they are certainly related, terms such as "tons emitted per year" are not as significant as "parts per million at ground level."*

Research to study reactions in which nitrogen oxides take part, other than in the formation of photochemical smog must be carried out. What happens to the oxides of nitrogen once they are emitted? Maynard Smith indicated that this is the kind of information that is needed in the research on sulfur dioxides. May I suggest that the same kind of information should be sought on the oxides of nitrogen?

With this information available, further research on control of nitrogen oxides can proceed on a sound technological basis.

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*See paper by Philip Sporn, p. 143.

". . . Congressman since 1959 . . . former Mayor of Middletown, Conn. . . . member of House Committee on Science and Astronautics . . . chairman of its Subcomittee on Science, Research and Development . . ."

A CONGRESSIONAL VIEW OF THE PROBLEM

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Appearing as the final speaker on this panel on heat and power generation leaves me in a very comfortable position. I know that the subject has been covered quite well by the excellent papers which preceded mine and therefore I can proceed somewhat reflectively, recognizing that this audience has already obtained a full measure of useful information.

I note that each of today's panel programs includes a member of Congress and I am pleased to join the distinguished group of my colleagues to add a legislative point of view to the discussion. The Congress has, in fact, often been a leader in working for air quality.

The Clean Air Act and its recent amendments are a manifestation of the recent consensus among citizens, industrial leaders, and local government officials. This consensus holds that dirty air is an unwanted and unnecessary consequence of our highly industrialized society. Unwanted because of the costs of pollution to health, to property values, and to our esthetic senses. Unnecessary because we have the science and technology to develop the required level of control on a cost-effective basis.

As Chairman of the Science Research and Development Subcommittee of the House Science and Astronautics Committee, I have long been concerned with applying our science and engineering resources to public needs and public purposes outside the military and space programs. Some time ago, as an indication of that concern, the Subcommittee identified environmental pollution abatement as a national objective which was highly dependent on the most effective utilization of new technology.

The legislation which was developed and improved by the House Interstate and Foreign Commerce Committee, and the Public Works Committees of both the House and the Senate, is well designed to deal with the gross and obvious forms of pollution.

These bills have been passed, either with no opposing votes or with very large majorities—as if to say to the Executive agencies: "Get organized for a sustained, high level program"; and to the technical community: "Give us new approaches and efficient operation of existing technology." It should be clear to all that there is more presently available and adequate technology than there is the money (or, sometimes, the will) to do it.

And yet, this very fact is a stimulus to an enhanced research effort. We know that when common problems such as smoke and fly ash are solved, there remain subtle but threatening contaminants, such as sulfur dioxide, nitrogen oxides, and very fine particles. We have the time to do scientific research about these less obvious irritants because abatement resources should be, and, I believe will be, first concentrated on the more obvious pollutants.

Therefore, it appeared timely to conduct an investigation into the status of environmental pollution technology so that the Congress might judge whether the goals and timetables for advances in waste management were based realistically on scientific and engineering capabilities in being or under study. Hearings were held, as has been said, during last summer and the Subcommittee issued a report a few weeks ago. Several people on today's program made important contributions to the testimony we received at that time. I would like then, to discuss a few of our conclusions which have particular relevance to our subject today, the generation of heat and power.

We found that the technical aspects of pollution were not receiving the best efforts of the science and engineering community. This is due to several factors: the unglamorous nature of the field relative to electronics, space and weaponry; the interdisciplinary nature and incoherent uncoordinated breadth of the problems; and the lack of research strategy and response to the Report of the President's Science Advisory Committee, entitled "Restoring the Quality of Our Environment." The private sector skills and facilities have not been motivated and brought to bear on the problem because criteria and standards cannot, as yet, be firmly established.

The lack of definitive standards should not be used, however, as an excuse for inactivity by industry. Even if we do not know exactly how to specify ambient air quality, we do know that a downward trend is indicated for almost all emissions. Therefore, while admitting that much more knowledge must be gained, we look to industry to equip new plants with control equipment and plan investments to modify older plants to reduce air contamination.

One of the impressive arguments for this interim approach is the fact that, within most industries, several individual plants can be found which are doing a good job already. In testimony before my Subcommittee we learned how Los Angeles has achieved control of stationary sources of pollution. Their report, entitled "Air Pollution Engineering in Los Angeles County," details the means for abating a wide diversity of emissions to the air.

In some cases, problems have been permanently solved, while in others, the technology is just keeping pace. In any event, their 18-year struggle has shown that much can be done now.

The results are a powerful stimulus to industry elsewhere, in areas where urbanization and meteorological effects are just beginning to create Los Angeles-type conditions. These results also provide significant ammunition for other local air pollution control officials to counter the public and private reluctance to act now.

I believe we should extend the collection of demonstrated successes in abatement to a worldwide basis. The exchange program between West Germany and the United States through the Department of the Interior is a promising start.

The first International Clean Air Congress, recently held in London, suggests a nongovernmental cooperative venture for dissemination of this information. The World Health Organization of the United Nations would seem to have a definite role to play.

Since pioneering successes in air pollution control have been achieved at high cost, other communities should not have to repeat these experiences in order to begin the reduction of air contamination. The benefits of known technology can give us an immediate start toward the ultimate goals of air quality which will be set, and met, by further research and development.

The fundamental information for eventually setting limiting standards involves ecological studies which are as yet incomplete, and in some instances not even started. These measurements of the effects of air contamination on human health and the living environment are a very difficult field of science. Without them, argument will continue in a rather uninformed way which will confuse the public and frustrate both industry and public officials. That is why our Subcommittee's first recommendation was this:

To improve our knowledge of what we are about, scientific activity in ecology and related fields should be immediately expanded to provide:

- Baseline measurements in plant and animal communities and the environment—an ecological survey.
- Continued monitoring of changes in the biosphere.
- Abilities to predict the consequences of manmade changes.
- Early detection of consequences.
- Knowledge of the environmental determinants of disease.

In other words, the first requirement with which the Congress challenges the technical community is to describe and to predict—and these are certainly the fundamental functions of science.

Let us take sulfur dioxide as an example of our limited abilities to deal with air pollution. One possible goal would be to prohibit any emission of this gas to the ambient air, thereby neatly removing the problem of whether lifetime exposures to low levels would cause harm.

Such a decision would disregard the practical value of the atmosphere as a dispersal medium for gaseous wastes. On the other hand, since sulfur dioxide would eventually be washed from the air, the assimilative capacity in the vicinity of power plants is a reasonable and natural alternative to complete suppression of emission.

However, we suspect that, along the way from the top of the stack to eventual repose in some stable chemical form in the landscape or ocean, the sulfur dioxide may combine with oxygen, water, and small particles in high enough concentration to be a hazard to public health. So, some limiting concentration might be specified for the receiving air mass. And that is where our current information fails us, as far as I have been able to ascertain.

Still considering sulfur dioxide, let us assume that a limit must be set, arbitrary though it may be. The question which policy makers then ask of engineers is of the cost-benefit analysis type. We would expect that all the aspects for quality within a given air mass or airshed should be considered. These include the difficult questions of the rights of presently installed plants versus the need for additional industry which may increase the ambient air concentration. We ask for a comparison of various approaches such as high stacks and standby fuels.

All of the costs and all of the benefits need to be put into that analysis. And, incidentally, I think a psychological advantage might be gained if this familiar phrase were inverted to read "benefit-cost analysis," since there is already too great a tendency to say that costs outweigh benefits.

The systems engineering approach appeals to Congress, apparently because it allows the placement of different responsibilities where they belong. First, the technical problems are converted by scientists and engineers into a series of alternatives. Then, public and private management officials can choose a course of action which they deem to be in the best overall interest of our society.

One result of system analysis may be the discovery that *all* possible solutions to a problem are too costly, and that much more research and development work is needed. That being the case, we badly need to separate these situations from those where the danger is so great or the remedy so clear that abatement must take place immediately.

Additional research and development can be provided as far as money, manpower, and facilities are concerned. What may not be within our power is the necessary time to obtain the advanced technology for abatement. That is why I am so concerned that we move more quickly toward an "early warning" capability for environmental effects.

This analogy to our national security military warning systems would give us the time to revise the activities of society, or to take countermeasures, when manmade disruptions appear to be going contrary to our best interests. Early warning will require both the ecological and the systems analysis knowledge I earlier outlined.

The complex problem of the increase in carbon dioxide in the atmosphere from fossil fuel combustion and the disposal of reactor wastes from enormously expanded nuclear electric power generation are two examples where an early warning is needed to direct research, development, and deployment of technology.

In the second progress report of our Subcommittee, we suggest an innovation which might use the input from an early warning system, that is, the technical facts and appraisals. We are exploring legislation to establish a Technology Assessment Board—with the acronym TAB revealing its purpose of keeping tab on the potential dangers as well as the benefits inherent in our enormous forces of environmental change.

TAB would not have regulatory powers such as those of the Civil Aeronautics Board nor cease-and-desist authority such as that of the Federal Trade Commission. Rather, it would spot and gauge the consequences of actions well before they were crystallized—and TAB would inform the public for responsible democratic decisions.

In the past, we may have been able to let these problems come to light in their own way because environmental change was rather slow. But powerful new forces, worldwide application, and the exponential expansion of knowledge make a new approach mandatory.

We are living well, thanks to a fast-paced, highly technical economy. Our industrial life is commensurate with our environmental health. Our ability to raise the standard of living throughout the world depends on a continued blooming of technology, and the new conservation of wise usage and recycling of resources. Surely, we can employ science and engineering to give us a balance of benefits at the expense of neither industrial progress nor environmental quality.

In these terms I believe that technology-based industry should take a much brighter view of the current surge of pollution abatement than has been indicated by some recent testimony, press releases, and public relations advertising. There is too much reactive defense of manufacturing, and processing, and heat and power production.

I should think that the laboratories of these same industries would be a primary source of the new devices and techniques to overcome pollution. There will be a tremendous market created in the near future, partly by government regulation, and partly by normal economics, since the true costs of pollution are placed on price tags, balance sheets, and tax bills.

Unlike the military-space programs, the Federal government is not going to be the major customer for abatement technology; and also will not pay for most of the development cost. The market lies in the private sector. The Federal agencies will fund research to provide basic information. They will also, I presume, stimulate development to assure that it moves along in a timely manner.

Government should underwrite demonstration of new abatement methods which must be proved out on a large scale, such as in model cities. But the key to better environmental quality is in the creativity of industrial laboratories and in the profit motive of private sector management. Thus, an early warning can also be an early indication of business opportunity.

The topic of heat and power generation is one of the most crucial with regard to early warning in policy planning. The capital commitments are so large, the equipment life so long, the quantities of raw materials and effluents so great, that the most careful considerations are warranted.

With most of you, I have been musing over the report, "Energy Research and Development and National Progress," released recently by the White House Office of Science and Technology. It seems to me that this report reinforces many of the conclusions from other sources which have been given to the Congress and which gave us concern. To some, the report is optimistic in stating that "presently foreseeable total resources will indeed be adequate to meet total energy needs without major cost increases for the remainder of this century, and for a considerable time thereafter."

The problem that bothers me is the degree to which our current decisions may bind future generations beyond this century or the next or the next. What is our responsibility? Does it depend just on what we know and can predict, or does our responsibility prevent us from a course of action if we cannot be reasonably sure that there are no irreversible and undesirable consequences? We all certainly believe that there will be a civilization on earth several hundred years hence. Recognizing all our foibles, I am not ready to write off the human race.

If you will concede me this point, then it becomes apparent that management of energy resources is a very important issue today. With the exception of the energy we obtain from the sun, energy is an irreplacement commodity. More important to us are the different sources, such as oil, coal, and uranium—and their abundance or scarcity.

Fossil fuels are disappearing, although we may argue about the rate. We have no really long term plans for these deposits, which represent the accumulations of millions of years. Economically recoverable oil and gas will be the first to be exhausted if the present rate of consumption continues. And yet, today they represent the source of about three-quarters of our consumed energy. Thus, whether we are ever energy-starved or not, we may be in for some drastic changes in use patterns.

The portability of liquid fossil fuels as a power source is their great attraction. The petrochemical industry is based on oil and gas as raw materials. We have heard the argument that these materials might be reserved for a higher use than present day economics might dictate. On the other hand, perhaps coal can be efficiently converted to substitute for oil and gas. Perhaps cheap nuclear energy will enable us to synthesize hydrocarbons from carbon dioxide in the air and hydrogen from sea water.

One ingenious plan presented to our subcommittee would take advantage of two space-age developments to circumvent pollution. First, nuclear electric energy would be used to separate hydrogen and oxygen by the electrolysis of water. The hydrogen would be liquefied and distributed in cryogenic containers as fuel which, when combusted with air, would produce only water, no noxious byproducts. Second, the nuclear powerplant wastes would be concentrated into small packages and deposited in outer space via rockets.

The fact is that nuclear energy has become that "something which will turn up." It is a most promising answer to pollution of the air. Adverse reports in the next few years on the carbon dioxide effect might bring a crash program to install nuclear electric power. In any event, it must be successfully used for the long run.

Our present investment in research on the unanswered problems of its use certainly makes me uneasy. We are assured that concentration of high-activity, long-half-life wastes from nuclear power will ease the disposal problem. But disposal is by burial and there is an eerie connotation to the statement of the Atomic Energy Commission that "final disposition of these wastes is readily achieved through commercial land-burial operations at special locations on Government-owned land . . . where the necessary perpetual control is assured." The necessary *perpetual* control!

There should be no honest opposition to the development of nuclear energy, but the foregoing discussion lays a challenge to science and technology to look into all the aspects of its expanding future use. And real risks are apparent, which may have to be countered with expensive techniques that will alter the economic choice among power sources.

In summary, my point is that there is need for clarification of all the ramifications of heat and power generation from various sources. We have the time to get the facts for future policy decisions. There is no panic, no crisis; there are no unanswerable questions.

The scientific, engineering, and economic investigations should proceed on a timetable that would: first, give us the fundamental ecological information to gauge the effects of alternative power-production schemes; second, improve our knowledge of reserves of fossil and nuclear fuels; and finally, relate the total costs of different fuels to the benefits and conveniences in specific applications.

We have the potential for abundant energy. We have the technology to convert energy from one form of fuel to another if this is required. We do not yet have all the facts needed to make decisions for the optimum and wisest use of our energy resources. Those facts related to the environmental pollution effects of alternative fuels will be vitally important to future energy policy in this country.

QUESTIONS AND COMMENTS

CHAIRMAN WESSENAUER: I will call on panel members in turn and give each one an opportunity to answer one of the questions he has been asked.

QUESTION: Mr. Smith referred to the half-life of air pollutants. If my memory is correct, he gave figures for the half-life of SO_2 at the conference of four years ago. Does he know if there are any data available for any of the other major air pollutants, for example, nitrogen oxides or hydrocarbons? Also, what is the mechanism of removal? Is it washing or settling out, combining with particles, or altering into harmless forms?

SMITH: That is a large question. The questioner is right as to my earlier mention of a half-life; this was worked out mathematically for a specific study quite some time ago for SO_2 and it turned out to be about four hours. However, the subject came up in the Gordon Conference in June 1965, the proceedings of which are never published. I think I can summarize what was said about the fate of sulfur oxides in the atmosphere. We know appallingly little of what actually happens to sulfur and at present I don't think anyone would dare to offer any estimate of its half-life or the precise mechanisms that are important in its removal or change in the atmosphere. In terms of other gases, I can offer no information that would be helpful to you.

For small particles, we do know a little bit more and we're gaining information all the time. The present evidence is that for the small particles, which are typical of those that remain after the precipitators do their work, the primary removal agent is probably precipitation—rain and snow—and the rate of removal is small, probably quite a bit smaller than we had originally anticipated. For these, I think, half-lives on the order of weeks would be an appropriate first guess.

QUESTION: What average ash in coal content was assumed when ash emission data were projected?

MOORE: We used a figure of 10 percent ash. The second part of the question is: How do the collector efficiencies selected relate to the latest ASME APS #1 Emission Standard?

They would tend to give a lower ash content.

In response to the third part, "Do the efficiencies result in exceeding the requirements of the standard?" my answer is yes, they would exceed the proposed standard.

QUESTION: In Mr. Diehl's paper he says that the nitrogen in the fuel is not the source of the nitrogen oxides. Please amplify.

DIEHL: First of all, may I correct the question. I say "is not the prime source of the nitrogen oxides." In answering this question, I have to draw somewhat on first-person experience. Back in those early days of nitrogen-oxide research that I mentioned, an attempt was made to establish just this fact—that the nitrogen in the fuel was an important part of nitrogen-oxide formation. I say that an attempt was made to show this, because this was the question. We were able only to make inferences from a series of tests on different types of units burning different types of fuel and in one particular case, on two units burning the same gas fuel.

The same gas fuel burned in two boilers gave nitrogen oxide values of essentially a 3-to-1 difference between the two units. And we observed pretty much this difference in the level of nitrogen oxides when we burned coals which essentially have 1.5 to 1.7 percent nitrogen across the board, and gaseous fuel—natural gas—which has very small amounts of nitrogen.

The data which we accumulated seemed to show that it was more a function of how the fuel was burned and the particular configuration of the heat-absorption surfaces within the furnace. The type of cooling, the rapidity of cooling, and the other factors seemed far and away to outweigh the nitrogen content of the fuels.

QUESTION: What effect will reduced-sulfur fuel have on the efficiency of dust-collecting equipment?

MOORE: If you consider sulfur all by itself, it will, in most cases, increase the cost for a given performance level. We selected 2½ percent sulfur as an average, but if the sulfur content goes down to 1, it will obviously increase the cost of the equipment, simply because it will be bigger. However, as in many questions like this, you always have to find out what else is changing and, if the temperature—the exit gas temperature—is changed along with the fuel and with the percentage of sulfur of the fuel, this would have a very definite effect on the cost. Low-sulfur fuel combined with low temperature is not going to be nearly as hard to handle as low-sulfur fuel with high temperature.

QUESTION: Are the quoted efficiencies for both electrostatic and mechanical collectors design figures or operating figures which are guaranteed?

MOORE: They are operating figures. Most air pollution control regulations are based on operating tests, not on design calculations.

QUESTION: Are any attempts being made to reduce the nucleons or haze-formation potentials of stack emissions? If the weight of the emissions is reduced, is the number of long-lived particles reduced?

MOORE: I am assuming that the question refers to particulate size. I believe it's a well-known fact that the smaller the particle, the greater its light-scattering ability, or the greater its potential for obscuring one's vision. So, if you have a large number of very small particles, it would obviously give you a haze or a stack with high obscuring power. It's also safe to say that a very small particle, of one micron or smaller, will obviously be a nucleus for picking up other constituents in the gas stream which could contribute to haze.

ARTHUR M. SQUIRES (*Professor of Chemical Engineering, City College, City University of New York*)*:* Two speakers this afternoon, Paul Spaite and Erle Diehl, have mentioned the possibility that "clean power" systems may be developed which will contribute to solving the power industry's air pollution problems. I think it would be worth the conference's attention to consider briefly what such a clean power system might consist of.

Figure 1 shows the broad idea, which is to gasify the raw fuel at high pressure, and then to clean up the very small volume of gaseous fuel which results, using equipment which can be quite small in physical size. One would recover elemental sulfur for sale to the market, and one would commit the clean fuel gas to some sort of advanced power cycle specifically engineered for clean fuel. As I have noted in Figure 1, the advanced power cycle will, hopefully, have a heat rate such that the saving in fuel plus the considerable revenue from the sale of sulfur will pay the costs of the pressure gasification and the gas cleaning.

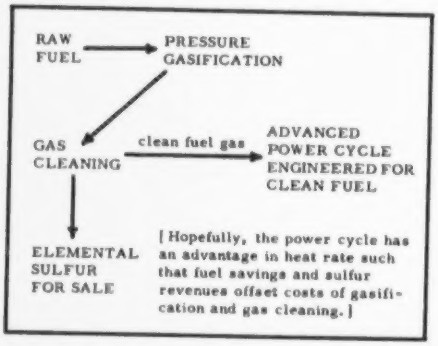

RAW FUEL
PRESSURE GASIFICATION
GAS CLEANING
clean fuel gas
ADVANCED POWER CYCLE ENGINEERED FOR CLEAN FUEL
ELEMENTAL SULFUR FOR SALE
[Hopefully, the power cycle has an advantage in heat rate such that fuel savings and sulfur revenues offset costs of gasification and gas cleaning.]

FIGURE 1

COAL GASIFIER ? ? ?

CAUTION: SCHEMES FOR PIPELINE GAS OR SYNTHESIS GAS GIVE THE WRONG IDEA!

THERE ARE NO SPECIFICATIONS AS TO EXACT HEATING VALUE OR BURNING CHARACTERISTICS

DESIDERATA:

LARGE UNIT CAPACITY
COMPLETE COAL UTILIZATION

FIGURE 2

Figure 1 fairly bristles with development problems, and also provides fertile ground for invention. In thinking about the advanced power cycle, one may ask, how might power technology have developed if the industrial revolution had been based on natural gas? Suppose coal were unknown and this planet had had far greater supplies of natural gas, which people knew about in the Middle Ages—coming from fissures in the ground, perhaps—and suppose they also knew how to pipe it into their homes and to burn it for heat. Suppose Watt had had gas and not coal when he invented the steam engine. One feels that a different power technology would have developed, and one readily persuades one's self that this would be today providing heat rates at least 10 per cent better than our current heat rates. If one wants to dream a little, one can imagine something on the order of 20 per cent better. One can really have a field day imagining inventions to be used in the right-hand part of Figure 1.

The gasifier is also a difficult problem. With fuel oil, solutions are relatively easy to find, but we have seen from Paul Spaite's Table 1 that fuel oil constitutes only about 5 per cent of the problem. The real difficulties, of course, come with coal.

My Figure 2 relates to the big question of the coal gasifier. Some of you may be familiar with work that has been done and is now going on, under the sponsorship of the Office of Coal Research, for producing pipeline gas from coal. I want to point out that the various schemes to make pipeline gas give the wrong idea entirely. I am talking about far simpler plant, which need not meet a rigid specification as to exactly the type of gas to be produced.

The chemical engineering profession can play a heavy role, I feel, in developing coal-gasification processes to meet the needs of the power industry. In one's thinking about these processes, the situation today is a little like the case of atomic power in 1950, when many reactor "concepts" were under review. Today we need new gasifier "concepts." We need to get to work to evaluate a great many ideas, and then to select the ones which best deserve the available development funds.

QUESTION: According to preliminary work by TVA, was it not reported that an increased amount of sulfur was arrested from stack gases by using very high efficiency electrostatic precipitators?

SPAITE: If there was such a report, I am not aware of it. I presume that the question is asked to precipitate an opinion with respect to whether or not such techniques would be useful in substantially reducing sulfur in flue gases, and my answer would be that I'm sure it wouldn't.

JOEL L. DURNIN (*City Air Pollution Control Engineer, Tacoma, Washington*): I am wondering if we couldn't go beyond the collection of sulfur oxide and try to find out how to dispose of this byproduct. Supposing we can collect sulfur oxide and make sulfuric acid from it—what can we do with the sulfuric acid? In Tacoma, we can't dump it in the Bay. I think the Fisheries Commission and the Water Pollution Commission would frown on that.

SPAITE: I mentioned in my discussion that no process is going to be universally applicable. Processes which produce sulfuric acid would be limited in application practically to those locations where a market exists. Other processes which produce other byproducts would undoubtedly give rise to other problems. The alkalized alumina process that I mentioned produces sulfur as a byproduct. I also mentioned the limestone process. This would produce a mixture of sulfur-laden calcium compounds and fly ash. It is relatively inexpensive and we hope that such a process would not be dependent upon recovering sulfur or marketing sulfuric acid.

However, it is recognized at this point that process costs are not well defined, and it may be important in the limestone process to find a use for the mixture of calcium compounds and fly ash that would be collected in the conventional particulate-control equipment. I think it's reasonable to suppose, from the nature of the compounds, that we could find some use for them. One possibility might be a soil conditioner, if one could prepare one from the byproducts with minimal processing and construction.

COMMENT: Many of our copper smelters use their sulfuric acid to produce phosphate fertilizers, and here we have a problem. We emit fluorides, which still constitute a problem, and possibly we could use sulfuric acid to produce plaster of Paris.

". . . researcher and educator in field of air pollution . . . for ten years carried on air pollution research for the Public Health Service . . ."

CONCLUDING REMARKS

ROY O. McCALDIN
Professor,
University of Florida
Gainesville, Florida

Secretary Udall furnished a clear statement of public policy for us when he said that we can have a successful industrial society and have a clean environment. The speakers have, with considerable care, described the air pollution problems associated with power generation and the steps under way in seeking solutions to these problems.

What strikes me most about today's account, is the tremendous vitality seen in the nation's electric power industry. It has been doubling in size every ten years.

Nuclear energy is becoming competitive with fossil fuels. It has been estimated that 32 percent of new power capacity in this and the next decade will be nuclear. Between 1980 and the year 2000, it is estimated that 86 percent of all new capacity will be nuclear, and current indications are that the rate of progress for nuclear power may be even faster than these estimates indicate.

Despite the anticipated rapid growth of nuclear power, the projections for coal use show a 55 percent increase between 1960 and 1980. A 22 percent increase is projected for fuel oil during this period.

The trend is also toward larger and larger power generating facilities. Sussman pointed out that in 1952 there were no plants greater than 1,000 megawatt capacity, and by 1962 there were fifteen. Along with these big plants, taller stacks are being built to dispose of the combustion effluent. Stack heights of 800 to 1,000 feet were mentioned.

Sulfur dioxide has been cited as the most troublesome of pollutants. It is emitted when any sulfur-bearing fuel is burned. Coal and residual fuel oil have quantities of sulfur varying from less than 1 percent to 5 and 6 percent. Average figures for sulfur in both coal and fuel oil run about 2 to 3 percent.

Various approaches to the SO_2 emission problem have been described by the speakers, and, as Congressman Daddario pointed out, when technical problems are converted by scientists and engineers into a series of alternatives, public and private management can then choose the course of action they deem in the best interest of society.

Among the presently available alternatives the use of low sulfur coal is definitely desirable. Federal regulations under consideration will require that Federal agencies in New York, Philadelphia, and Chicago use only low sulfur fuels. I understand that these steps were promulgated to minimize the government's contribution of SO_2 to these areas that experience some of the highest SO_2 levels in the country. Widespread use of low sulfur coal is complicated by the fact that most of the supplies are not convenient to this market.

Substitution of natural gas for coal or oil has much appeal as an air pollution control measure, since natural gas contains practically no sulfur and no ash. Chairman White of the Federal Power Commission pointed out that there are many competing uses for natural gas, and the merits of using it as a clean fuel to reduce air pollution would have to be weighed against the merits of conserving it for other purposes; and he indicated that this should be done on a case-by-case basis.

Another alternative is to isolate the power station so that its effluent will not be additive to urban pollution levels. A variation to this idea, brought out by Mr. Sussman, is to shift loads among power stations within a large geographic network so that minimum amounts of fuel would be burned in an area experiencing an air pollution alert. The principal difficulty with this, of course, is in having sufficient reserve capacity to permit redistribution of load.

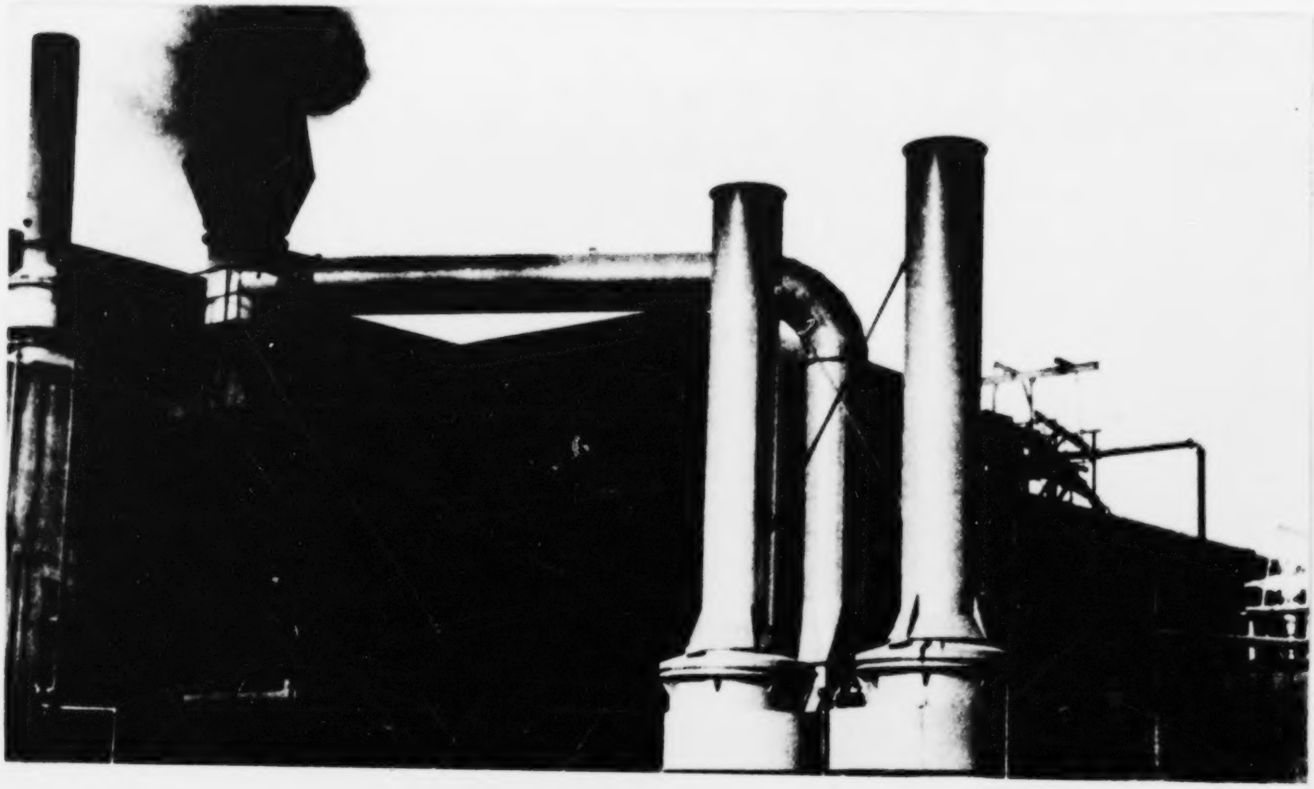
Another approach is to desulfurize the fuel before it is used. Pyrites, which amount to a portion of the sulfur in coal, can be removed by gravitational methods. Organic sulfur bound in the coal cannot be removed this way. Sulfur can be removed from residual fuel oil, but, I gather, the cost of doing this runs between 10 percent and 40 percent of the fuel cost, and thus is not economically desirable.

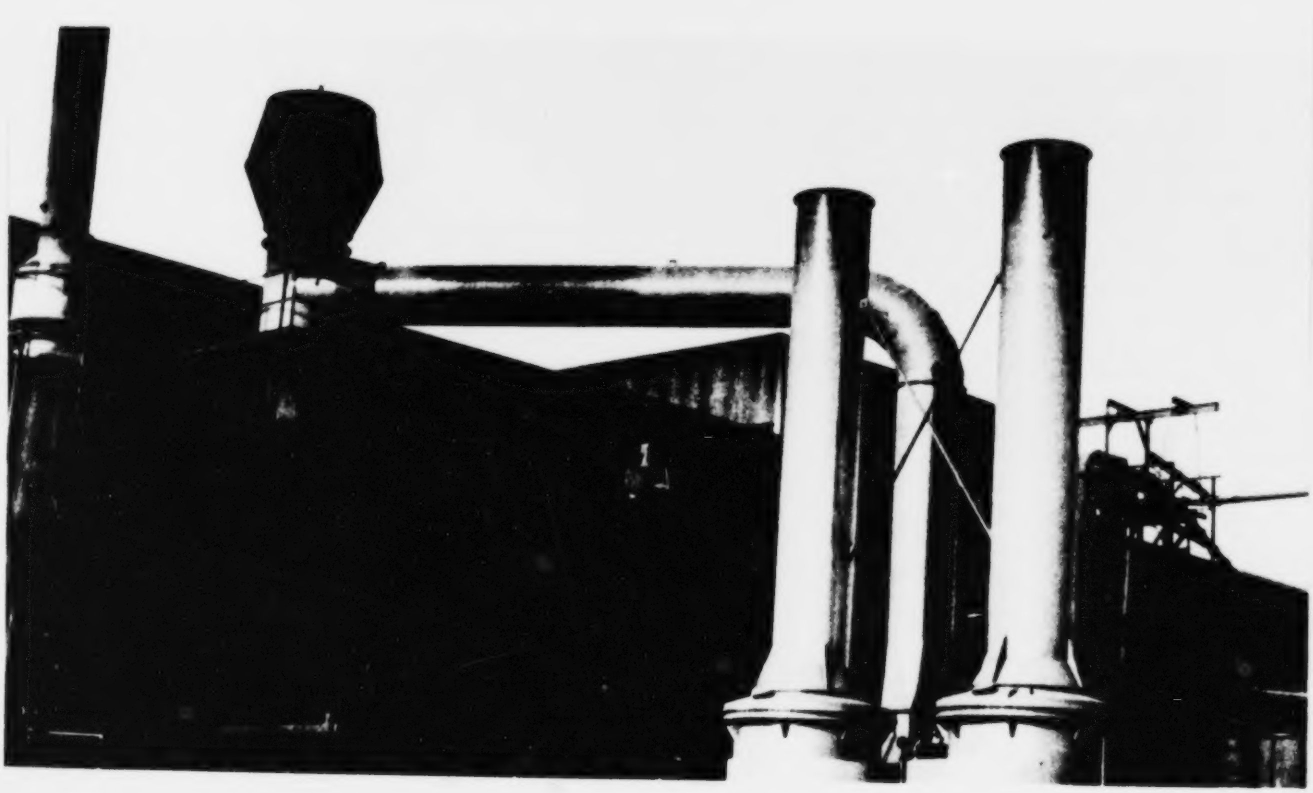
A number of experimental and pilot methods were described by Mr. Spaite for removing SO_2 from flue gases. In some procedures, the sulfur is collected in the form of H_2SO_4, and a nearby market is needed for this product. In other procedures the sulfur is collected as a salt and disposed of as a waste product. And in yet another technique, the sulfur is collected in its elemental form for any of a number of further uses. This last procedure, I think, should be the most desirable in that it reduces pollution and conserves a natural resource. The principal point that struck me was that none of these methods is as yet economically feasible for full-scale use. Further work in this area is sorely needed.

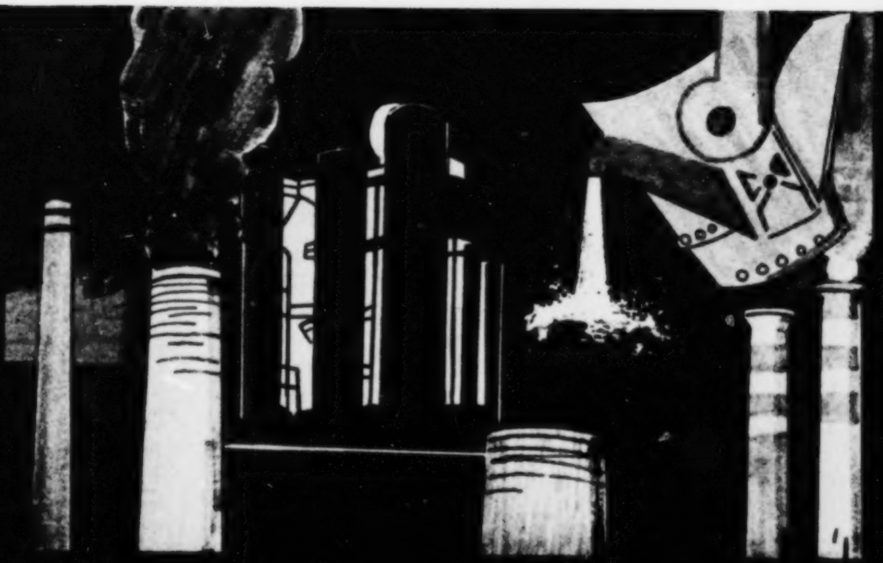
That takes us back to stacks. The power industry is making better and better use of tall stacks to reduce ground level SO_2 concentrations. Dr. Smith aptly described the mechanisms by which these ground level reductions are brought about. He and Congressman Daddario both introduced a most interesting idea—that of atmospheric half-life of contaminants such as SO_2. It is possible to envision a physical cycle where SO_2 is emitted to the atmosphere, dispersed by winds, and removed from the atmosphere by rain and by contact with the earth's surface. It is also possible to envision a chemical cycle going on at the same time, whereby SO_2 is gradually oxidized to SO_3, then in the presence of moisture becomes H_2SO_4, and finally reacts with materials, either airborne or on the earth surface, to become an acid salt or sulfate. Its ability to do damage would vary depending on its concentration and chemical state at any particular time during the decay cycle.

Particulates are another major emission from some fuel combustion. Coals contain ash in amounts from 5 to 20 percent, with an average around 10 percent. Various portions of this ash are entrained in the combustion effluent, depending on the particular combustion method. Fuel oil contains very little ash—perhaps 0.2 percent. Thus, ash emission is principally from coal combustion. Mr. Moore indicated that the average ash collection efficiency for utility coal is now about 86 percent, and collection efficiency for coal in industrial use is 62 percent. The principal point is that there are available means for removing 99.5 percent of the ash from flue gas streams, and that as new power generating facilities are built, this capability is being used almost to its fullest. Ash collection capabilities of 95 percent and up are being employed. Low collection efficiencies have been associated with smaller and older units, which are being relegated to standby use.

It was good to hear Mr. Diehl devote a full presentation to the oxides of nitrogen. These are emitted from combustion effluents in concentrations ranging from 100 to 1,000 ppm. The role of NO_x in producing eye irritating smog has been described, and I understand that eye irritants have been reported in more than 20 urban areas. However, the relative significance of NO_x from heat and power effluents as compared with NO_x in motor vehicle effluents, except perhaps in Los Angeles, has not been fully resolved, and thus warrants further inquiry.







C

December 13, 1966

PANEL C

INDUSTRIAL OPERATIONS

FIRST SESSION

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President, Air Pollution
Control Association
Baton Rouge, Louisiana

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". . . chemical engineer . . . coordinates Ethyl Corporation's air and stream control and waste disposal processes . . . expert in process control and development . . . president of APCA . . ."

STATUS REPORT

JAMES H. HUGUET
President, Air Pollution
Control Association
Baton Rouge, Louisiana

Welcome to Panel C, which will discuss industrial operations. We shall hear status reports and future prospects of air pollution control in specific industries.

I would like to change my subject somewhat in order to consider the actual mechanism of air pollution control within an industry.

I will start with top management. The company president and the board of directors must take a positive position that air conservation must be made a part of the overall corporate program. Of equal importance, they must see that their position is known at all levels of the organization. They must be willing to approve the needed expenditure of manpower and dollars.

In general, I believe that the top management and personnel of most progressive industries are well informed on most matters of interest to the public; as a matter of fact, they have to be. They get their information in many ways. On the subject of air pollution control, some of the industrial associations have been doing a very good job of keeping management advised of the trends in legislation and the public attitude. The Manufacturing Chemists Association, for example, regularly issues Federal and State legislative summaries. They also issue a very good monthly report to membership on activities and trends, and very recently have put out what, in my opinion, is a very excellent packet of public relations information on requirements of air pollution control.

The American Petroleum Institute issues a very complete newsletter and other releases on air and water conservation. Both the Manufacturing Chemists Association and the American Petroleum Institute have developed and issued statements of policy and you will hear about these later on our program; representatives of both organizations are on the afternoon panel.

One of the principles that both industry and control officials have always endorsed is that control must be at the local level. In view of our conference theme, *Control Now*, I would suggest that immediate action can result only from a directive which is addressed to a specific individual who is responsible for controlling a specific emission source. From the standpoint of industry, this means the local plant manager.

To expand a little bit on my statement—when my boss wants something in a hurry, he doesn't come in and make a general statement that it would be nice to have something—*He tells me to do it . . . now!* And I think that's the only way you get action, a direct order to an individual who has an individual responsibility.

The plant manager usually has a very good idea of what is going on in his area because normally he is pretty well tied up in the public relations program. And he is aware of public opinion. Of course, unless he is fully backed by top management, the plant manager cannot make much progress on controlling emissions or on requiring that new plants meet certain emission requirements. In order to be effective, he must also have technical personnel who are capable of assessing the control needs, designing the systems, coordinating the construction, and directing the start-up of these facilities.

There must also be access to the research and development department for initiating improved methods when necessary, and Research and Development must have a well-defined obligation to consider air pollution control as a process requirement in future process modification and in new-product development.

The plant manager also has a direct responsibility to see that the plant is operated in such a manner that emission is minimized and that pollution-control equipment is maintained in good working order and replaced when necessary. This means that each process operator and mechanic must have an incentive to achieve good working habits in control of emissions.

This requires more than a single directive by management. Programs to encourage and educate operating personnel to participate in air pollution control are essential.

Again, I think the Manufacturing Chemists Association has issued an excellent guideline for such a program. All of these publications I have referred to are available—both MCA and API are glad to send this information to responsible and interested people and I would encourage you to ask for it if you have an interest.

The basic outline of a positive plant-control program was suggested by one of our speakers, Dr. W. L. Faith, in the September 1961 issue of *Chemical Processing*. This is so fundamental that I believe it is worth repeating here. Following is a summary of his suggestions, plus a few of my own amplifications and additions:

1. Each plant should have a definite and clearly-stated policy that it intends to promote air conservation.

2. Each plant manager should appoint a technically trained employee to coordinate the air conservation program at that plant.

3. This coordinator should be assigned to specific tasks for determining the nature and the amounts of all plant effluents and the concentrations of pollutants in the ambient air in the vicinity of the plant.

4. Based on the above data, a program which will provide the necessary controls should be developed. This program should be long-term and should include both the necessary funding and a realistic timetable. Priorities must be set and, above all, available controls must be installed as quickly as it is possible to do so. Remember—CONTROL NOW. Something more should be done each year. Have a positive, progressive program and keep the schedule and plan up to date.

5. The coordinator should be consulted on possible pollution problems in the early stages of development and design of new processes because an evaluation that doesn't contain the proper cost for air quality control isn't complete. We had one in my company which was a case of the tail wagging the dog, because this new process would have produced a waste product which was slightly in excess, on a weight basis, of the primary product we were looking for, and the disposal of the waste product posed a major problem of economics.

6. The technical help needed from consultants and specialists must be provided. Maximum use should be made of the services provided by equipment manufacturers. Also, and very important, an active program of exchanging information between like industries expedites air pollution control, and this is something the coordinator should keep in mind.

7. The coordinator should be instructed to cooperate with the control officer and attend meetings of the local and/or State air control authority. He should participate actively in the development of regulations and programs of the control agency; you've got to be a part of it or you won't be with it.

8. In many industrial communities, groups form a type of association especially to assess certain area problems and to work toward their solution. A number of area surveys have been and are being sponsored and conducted by industry. If circumstances warrant in your area, I think you should consider such a program.

9. Stress air pollution control in your public relations program—both in the plant and in the community.

10. Control equipment in the plant must be maintained, and improvement in it is always possible. Air conservation is a never-ending job.

The availability of technical manpower experienced in air pollution control is a problem in many plant locations.

One of the conclusions of the excellent Congressional report, *Environmental Pollution—a Challenge to Science and Technology*, issued by the House Subcommittee on Science, Research, and Development, states: "Technical manpower will be a limiting factor in abatement progress unless additional effort is organized into retraining, graduate education, and transfer of skills from other technology programs."

The following suggestions for gaining a background in air pollution control may be helpful to inexperienced personnel who will be engaged in this work:

1. There are many good texts and handbooks on this subject. Accumulate a small library and set up an information file.

2. The U.S. Public Health Service gives short training courses at its Center in Cincinnati on a number of aspects of air pollution. (A listing of these programs is available.*)

3. A number of universities now have full programs and specialized courses on air pollution control. Universities and technical organizations have developed a number of workshop-type programs. These can be most helpful. Most technical and professional societies have sections devoted to air conservation: become active in them: attend meetings and seminars on air pollution control and air conservation.

4. As stated earlier, it is imperative to attend meetings of local and State control agencies in order to have a feel of the situation and current trends. (I have always found air control officials most helpful and cooperative to people interested in their programs.)

5. Most industries are eager to share information on pollution control and are usually receptive to on-site visits to observe their equipment and practices. A later paper will describe reports now being prepared on a cooperative industry-government program. Such reports provide excellent information on specific industries and several are in the mill at this time.

6. Undoubtedly, the most important and effective means of obtaining a background of competence in air conservation is through active participation in the Air Pollution Control Association. This growing organization now has over 3,500 members, mostly technical persons, who have interests in all phases of air conservation. It is the only national association devoted solely to air pollution control. APCA provides a realistic approach to clean air—an open forum for industry and government at all levels. Knowledge and experience are pooled and answers are found much more quickly with less cost and greater acceptance by all.

Each month, the *Journal of the Air Pollution Control Association* and *Abstracts* are published and mailed to members. The *Journal* contains articles about all phases of air conservation: the equipment section, especially, is of great practical value. The *Abstracts* are most complete.

The annual technical meetings held by APCA offer an outstanding opportunity to hear about the latest developments, to observe exhibits, equipment, and instrumentation, and to meet and discuss common problems with experts.

APCA is a member of the International Union of Air Pollution Control Associations, and the presidency of this Union will rest in the United States for the next four years. This is, I believe, a very necessary organization, and one which will extend technology and make full use of developments in other countries.

I do not think that it is possible to be effective and current in air conservation without being a member of APCA.

In summary, if we are to control now, we must intensify our efforts at the local level. Each plant must make air pollution control, air conservation, an integral part of its daily operation. A positive program today will give us clean air tomorrow.

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"commissioned in U.S. PHS in 1950 . . . doctorate in engineering and air pollution . . . designer of data processing systems and analyst in air pollution field . . ."

FUTURE AIR QUALITY STANDARDS AND INDUSTRIAL CONTROL REQUIREMENTS

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At this conference, three papers are being presented on future air quality standards and control requirements pertaining to combustion pollutants emitted from motor vehicles, furnaces, and incinerators. Papers on the control of pollutants from six major industries are being presented at the afternoon session of this panel.

In order not to encroach on any of the other papers, this presentation will concentrate on general considerations in selecting ambient-air standards, and how this information can be used together with air quality measurements to determine the source strength reductions needed to achieve various standards.

POLLUTANT EFFECTS

Public opinion, generally, appears to be that the quality of ambient air should be good enough that the health of even sensitive or susceptible segments of the population will not be adversely affected, and that pollutants should not be allowed to reach concentrations that will cause a nuisance, such as unpleasant tastes or odors; or to damage animals, ornamental plants, or agricultural crops; or significantly reduce visibility, that is, be a hazard to transportation.[1]

The consensus is not so clear on effects such as soiling of fabrics, corrosion of metals, damage to other materials, and obscuring natural scenery. The techniques presented here stress methods for selecting air quality goals that will prevent those effects that are objectionable to the public generally.

Exposure times needed to produce various pollutant effects vary. Odor, eye irritation, and taste can be detected when pollutant concentration exceeds the sensory threshold for about 1 second. If a large number of pollutant molecules need to be absorbed by an organism before an effect is produced, longer exposure times are needed. Thus, the stress of decreased oxygen-carrying capacity of human blood caused by carbon monoxide exposure in urban areas is best depicted by averaging concentrations over about 8 hours.[2]

Similarly, to determine pollutant levels that will cause acute plant damage, the concentrations need to be averaged over about 1 to 8 hours.[3] Averaging times of about 24 hours are probably adequate for evaluating soiling of clothes and household furnishings, and 1 month to 1 year for evaluating soiling and corrosion of buildings and metal products.

POLLUTANT CONCENTRATION

Air pollutant concentrations are a function of emission rate, emission height, and meteorologic factors such as wind speed and inversion height. All these variables together influence pollutant concentrations in urban areas in such a way that these concentrations tend to be lognormally distributed and thus form a straight line when plotted on standard log-probability paper (Figure 1).[1] These data can also be plotted on logarithmic paper (Figure 2), and the same type of information can be shown for various averaging times.

The results indicate that concentrations are approximately lognormally distributed for all of the general pollutants in all cities for all averaging times and that maximum concentration is inversely proportional to averaging time to an exponent.

The variability in pollutant concentration is indicated by the standard geometric deviation. The standard geometric deviation for 1-hour averaging times varies from about 1.5 to 2.5 for carbon monoxide, nitrogen oxides, oxidant, and sulfur dioxide in Chicago, Cincinnati, Los Angeles, Philadelphia, San Francisco, and Washington.[3]

This information can be used to calculate [4] that the maximum 1-second concentration in a year will be about 10 times the maximum hour, ranging from 5 times to 15 times, as the deviation ranges from 1.5 to 2.5. Similarly, the maximum hour in a year is about 2 or 3 times the maximum 24-hour concentration. These relationships hold for urban atmospheres containing pollutants from many sources.

Much wider variations in pollutant concentrations and much higher ratios of concentrations would be expected for pollutants coming from single sources. The relationships can be calculated from the standard geometric deviation of measured ambient concentrations.

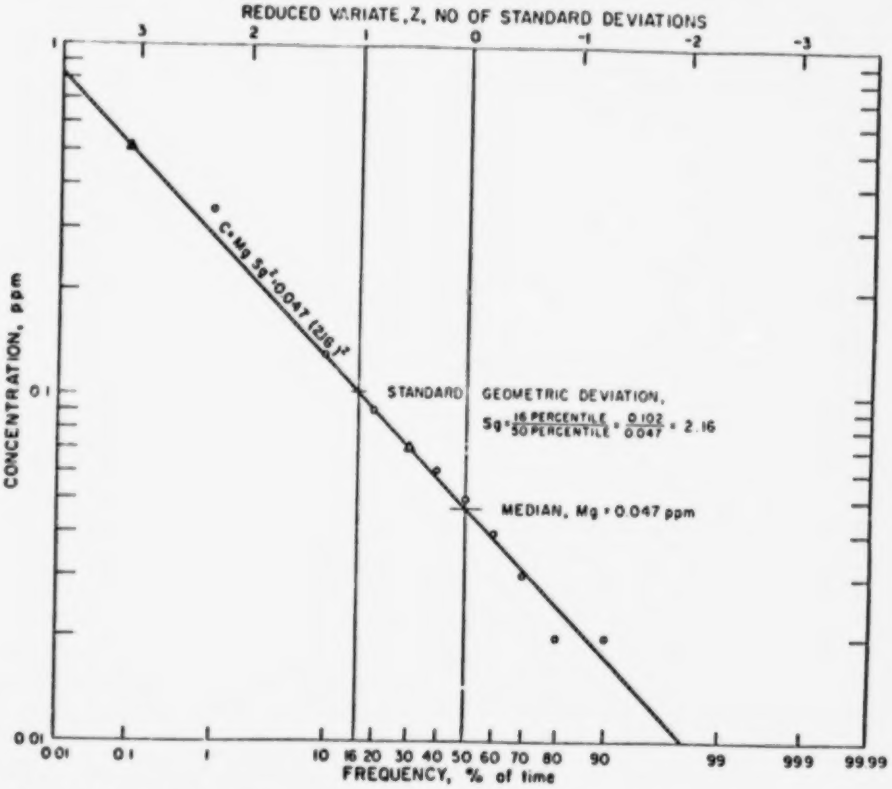

FIGURE 1. Frequency of various 1-hour averaging time nitrogen oxides concentrations in Washington, D.C., 3/1/62–3/1/63.

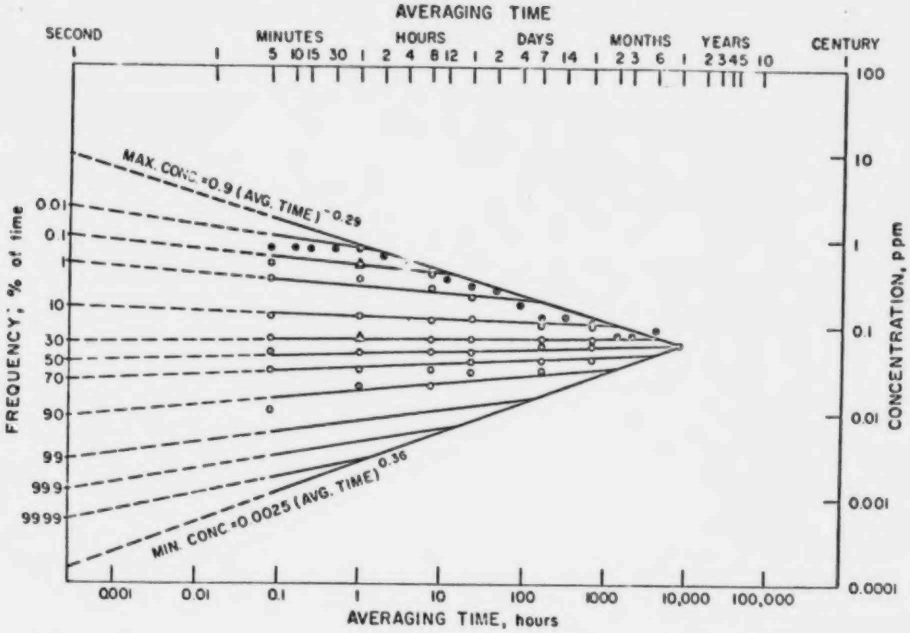

FIGURE 2. Frequency of various nitrogen oxides concentrations for various averaging times in Washington, D.C., 3/1/62–3/1/63.

CALCULATING CONTROL

Some air quality standards specify how frequently a certain concentration can be exceeded. A 24-hour-averaging-time standard might specify that it is not to be exceeded oftener than once a year or 1 percent of the time (3 times per year). An 8-hour-averaging-time standard might specify that it can be exceeded 0.1 percent of the time (once per year).

An arbitrary frequency should not be selected blindly. For instance, if one were to specify that 1 percent of the 1-second-averaging-time concentrations could exceed the odor threshold, odor could actually be detected on the average of once every few minutes.

It is probably safer to decide about how many times per year a certain concentration should be allowable, and then to convert that number into some even frequency, such as 1 percent, 0.1 percent, or 0.00001 percent, depending on the averaging time.

By themselves, air pollutant concentrations mean little. They take on meaning only when they are compared with the yardstick of effects they produce and with standards for controlling them. The purpose of this section is to demonstrate an example calculation of the degree of pollutant control needed to meet a given air quality standard.

The degree of overall average air quality control needed to meet a given standard can be calculated as follows: [5]

$$R = \frac{(100\%)(c-s)}{c} \qquad (1)$$

where c is the pollutant concentration and s is the standard concentration. Thus the overall average reduction in nitrogen oxides emissions needed in Washington, D.C. in 1964[2] to meet the Colorado standard is:

$$R = (100\%)\frac{(1.41-0.1)}{1.41} = 93\% \qquad (2)$$

Both industrial production and energy demands in the United States are expected approximately to double between now and 1985 (Figures 3 and 4).[6, 7] Thus, about 96 percent control will be needed by 1985. Both stationary and mobile combustion sources contribute substantially to urban nitrogen oxides concentrations. Thus, approximately 95 percent reduction of emissions from both of these sources would be needed to meet the Colorado standard.

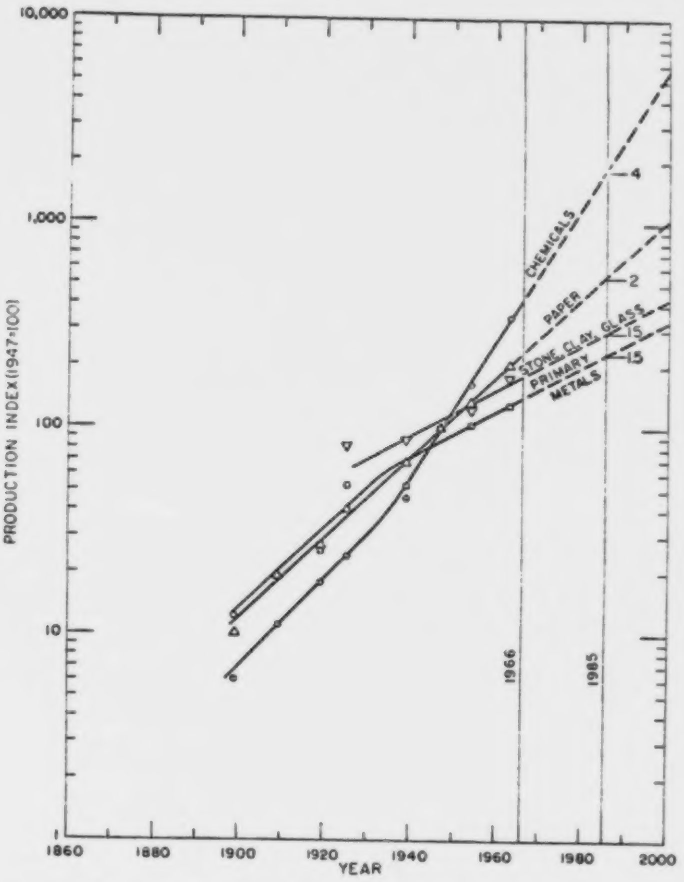

FIGURE 3. Production in the United States by selected industries, years 1900 to 2000.

To achieve this goal, stationary source strengths would need to be reduced to about 0.03 pounds of nitrogen oxides per million BTU input and mobile sources to an emission concentration of about 50 ppm nitrogen oxides. Since single-family homes represent smaller, more widely dispersed sources, the Colorado standard could probably be met if they emitted about 0.1 pounds of nitrogen oxides per million BTU input, which is approximately the present emission from small domestic gas-furnaces.

Equation 1 can be used to calculate needed source reduction when nonurban concentrations of a pollutant are negligible. Nonurban concentrations of suspended particulates, however, are not negligible, but approximate maximum values of about 75 micrograms per cubic meter. The effect of nonurban background concentrations can be considered by altering equation 1 to

$$R = \frac{(100\%)(c - s)}{c - b} \qquad (3)$$

where b is the background concentration.

The most important factor in air quality control is not the degree of control, but rather, the amount of pollution left after control. For instance, the maximum nitrogen oxides concentration in a city for a 1-hour averaging time might be 1.00 ppm. A 70-percent reduction in emissions would lower this to 0.3 ppm; a 90-percent reduction would lower the 1.00 ppm to 0.1 ppm. Thus, the concentration remaining after 70 percent control would be three times as great as that remaining after 90 percent control.

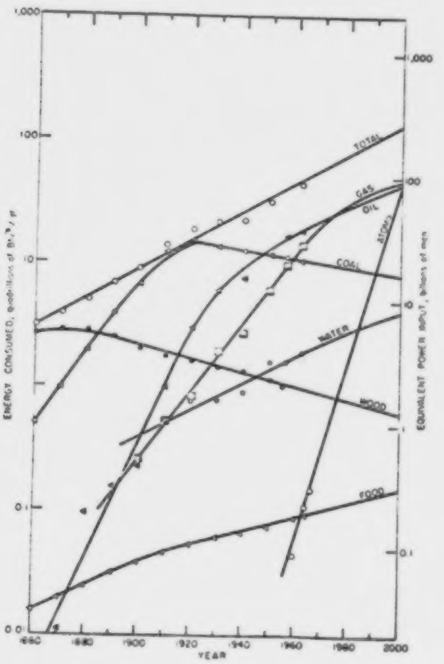

FIGURE 4. Energy consumed in the United States, by source, years 1860 to 2000.

STANDARDS

Many air quality standards are designed to keep pollutant concentrations below the odor threshold. USSR scientists go one step further. They recommend standards that will prevent the first detectable physiologic response (Tables 1 and 2).[8] Thus, USSR recommended levels are usually lower than others. The maximum concentrations for metals measured by the National Air Sampling Network (NASN) have been compared with the USSR standards (Table 1).[9] Comparative data were available only for chromium, lead, and manganese. In NASN samples, lead is the only one of the three that has ever exceeded the USSR standards. This does not mean, however, that there is no problem. Some trace metals, such as beryllium, appear to be extremely toxic to sensitive individuals, and have caused illness and fatalities in a community atmosphere. Thus, the Atomic Energy Commission has recommended a low community standard for beryllium of 0.01 micrograms per cubic meter.

Cadmium is another trace metal that has been given attention.[10] The death rate from heart disease is one-third greater in cities with higher atmospheric cadmium concentrations (an annual average of 0.05 micrograms per cubic meter) than it is in cities with low cadmium concentrations (0.001 micrograms per cubic meter). These results are not related to city size or to the concentrations of other pollutants.

Cadmium apparently causes its adverse effects by concentrating in the kidneys. Atmospheric cadmium may enter the body by absorption in the lungs or by absorption from food and water into which atmospheric cadmium has settled. Future research may disclose additional trace metals that tend to concentrate in vital organs and cause adverse effects.

A few industries in the United States have air pollution problems due to the emission of metals such as beryllium, cadmium, or

TABLE 1.—*Comparison of U.S.S.R. air quality standards for metals with maximum concentrations measured on U.S. National Air Sampling Network, 1957–61*

Pollutant	Concentration (μg/m.³ for 24-hour average)		Maximum—U.S.S.R. standard	Location where maximum measured
	U.S.S.R. standard	Maximum measured on NASN		
Arsenic	3	....	....	
Beryllium, USAEC	.01	....	....	
Cadmium	....	0.17	....	Tacoma, Wash.
Chromium	80	1	0.01	Baltimore, Md.
Lead	.7	6.3	9.00	Los Angeles, Calif.
Manganese	10	2.6	.26	Cleveland, Ohio.
Mercury	.3	....	....	

TABLE II.—*Odor threshold and air quality standards for some industrial gases*

Pollutant	Odor threshold (p.p.m.)	Standard		
		Concentration (p.p.m.)	Averaging time (hr.)	Country or State
Carbon disulfide	0.02	0.003	24	U.S.S.R.
Chlorine	.27	.04	24	Czechoslovakia.
		.01	24	U.S.S.R.
		.1	.5	West Germany.
Fluorine		.005	24	U.S.S.R.
Hydrogen chloride	.07	.5	.5	West Germany.
Hydrogen sulfide	.01	.005	24	U.S.S.R.
		.1	1	California.
		.1	.5	West Germany.

lead. A few more are troubled by fluorides (from fertilizer and aluminum production) that damage plants and grazing cattle. Most industries, however, are plagued with three basic pollution problems: emissions of combustion pollutants, dusts, and odors.

Calculations indicate that highly efficient control of particulate emissions from major industrial dusty processes will be necessary to achieve the more stringent air quality standards proposed today. Baghouses and electrostatic precipitators could provide this control. If electrostatic precipitators are used, they must be carefully designed and operated to avoid production of appreciable quantities of ozone and nitrogen oxides from corona discharge.

Control of odors requires careful, persistent attention, especially since odors can be detected by the citizens of the community if the concentration exceeds the odor threshold for only 1 second. Scrubbing, catalytic combustion, or flame combustion can be used for control. Los Angeles' experience and rules and regulations should be valuable for specifying odor control.

Many industrial processes are presently open to the atmosphere. The trend will probably be towards completely closed processes. When closed processing is not feasible, local exhaust systems will be needed to pick up all pollutants (plus unwanted dilution air) and carry them to control devices. For especially troublesome pollution problems, new processes must be devised.

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". . . nationally known in air pollution control and environmental health . . . chief of air pollution control for Allegheny County from 1957 to 1965 . . . degrees in engineering and public health . . . on University of Pittsburgh faculty . . ."

DISCUSSION

FUTURE AIR QUALITY STANDARDS AND INDUSTRIAL CONTROL REQUIREMENTS

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Typical of Dr. Larsen's writing, his scholarly presentation is an impressive document of the widespread concern for future air quality standards. He has been assigned the difficult task of recommending air quality standards for the future and translating such standards into the degree of control that will be required by industry. The difficulty stems from the wide range of assumptions involved in making such predictions.

Goals and objectives are desirable in air pollution control as they are in all aspects of modern life. They give meaning and direction to our endeavors: they offer diverse community interests and incentives to align their efforts in a common undertaking.

Dr. Larsen's analysis of the dynamics of industrial growth is accurate. His assumption that the public desires air of high quality is fully accepted by industry. His caution that "by themselves, air pollution concentrations mean little" is most appropriate. His estimate that the high-efficiency bag filters or electrostatic precipitators will meet future needs and the suggestion for controlling odors by combustion (catalytic or flame), as is being practiced in various air pollution control districts, are reasonable.

Dr. Larsen omitted recommending any specific air quality standards. He cites the approach taken by Russia in establishing unusually low levels for certain potentially toxic gases, but points out that in samplings taken by the national air sampling network for those metals that are the same that Russia has—chrome, lead, and manganese—only lead has ever exceeded these Russian standards.

I was anticipating that air quality standards would be recommended. Their absence, I assume, is an indication that considerably more study is needed before such standards can reliably be made and that arbitrary standards—as Dr. Larsen said—should not be selected blindly.

His discussions of methods of calculating control raise some interesting questions for consideration. He properly points out the time-dose relationship of cause and effect.

There is the suggestion that a 1-second exposure to a sensory threshold can be detected. It has been my experience that complaints from the public come from repeated and prolonged exposures to sensory pollutants.

Dr. Larsen also says many industrial processes are presently open to the atmosphere, and states that the trend probably will be toward completely enclosing them. While undoubtedly some industrial processes now being carried on in the open can be enclosed, there are still others for which this solution is unlikely—in farming, for instance, in the tilling of the soil and aerial spraying; in the construction industry; in the moving of earth and the razing of structures.

I am sure Dr. Larsen has examined thoroughly the progress being made in the control of industrial emissions. Many communities also can show advances in controlling unwanted byproducts of our technological progress.

The records show that dustfall has dropped precipitously in many cities over the past five years. In New York City, for example, the reduction has exceeded 18 percent [1]; in Pittsburgh, it has declined from over 50 tons per square mile per month in 1950 to 28 tons per square mile per month.[2]

But when we add up achievements it is vital to take into account what we still don't know how to do.

In 1959 Lee Schreibeis, then Director of Air Pollution Control for Allegheny County, took advantage of a 116-day steel strike to measure the ultimate in control from steel emissions. His report shows that while dustfall declined substantially—approximately 50 percent—suspended particulates declined only 15 percent.

In his report Schreibeis allotted a substantial share of the remaining dustfall and 85 percent of the remaining particulates to Pittsburgh's blowing street dust, traffic abrasion, and natural sources, which will present a very difficult problem to eradicate.[3]

Schreibeis' findings form the basis of a cause-and-effect question: Can specific ambient-air-quality standards be postulated on the control of specific emisisons from defined sources?

From my point of view, the public interest lies in thorough exploration of all economic alternatives in achieving the maximum air quality commensurate with the public's total social needs.

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". . . engineering consultant, editor, writer . . . winner of editorial achievement awards . . . chairman of Industrial Pollution Committee for American Institute of Professional Engineers . . ."

AIR POLLUTION CRITERIA FOR INDUSTRIAL PLANT EQUIPMENT

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New York City

The word "criterion," according to the dictionary, means "a standard, rule, or test by which a judgment of something can be formed." For us, "something" would be the air pollution abatement devices for industrial plant equipment. And "a standard, rule, or test" for plant installations.

In the brief time we have this morning, I have summarized only the high points of a few experiences from actual control installations: the valued opinions of some, but not all, equipment manufacturers; and the hard work of a few professional societies and associations. What I am really saying is that this paper is not a one-man, one-society effort, but the result of cooperative efforts and experiences of many industrial plants, equipment vendors, air pollution control experts, and professional societies and associations.

From the Pollution Control Division, Chemical Construction Corporation, New York, we have the following evaluation of air pollution equipment criteria.

Generally speaking, the selection of the proper type of equipment depends upon three things:

1. The type of pollutant.
2. The particle-size distribution.
3. The efficiency desire.

The efficiencies are determined from the codes set up by the pollution control boards of the various states and/or localities. For instance, for fly ash emanating from pulverized-fuel-burning boilers, an electrostatic precipitator is usually selected to effectively clean the gases to the limits set by the various government agencies. In the case of stoker-fired boilers, a high-energy, dry-type cyclone does a satisfactory job since this dust is relatively coarse. In the case of a fume from a steel-making electric furnace, a high-energy, venturi-type scrubber will give satisfactory efficiency. A fabric filter may also be used for this application. In Table I we show additional examples of proper equipment application.

It seems there is always the decision between two basic pollution control systems: the wet (scrubber) and the dry (precipitator). The following table presents some general guidelines but, of course, is not necessarily the final word. Table II (Pollution Control Selection) is based on information supplied by Research-Cottrell, Inc., Bound Brook, N.J.

And the third table gives us an insight on relative costs of industrial control equipment. Table III, Pollution Control Cost Data, is a sampling of actual installations in the Los Angeles area. But the interesting point is the percentage relationship of the cost of the control equipment to the cost of the basic plant- or process-equipment being

TABLE I

Operation	Particle size	Normally used	Sometimes used
Chemical materials handling.	Fine to medium	Scrubber	Fabric filter.
Chemical roasters, kilns, coolers.	Medium to coarse	Scrubber	High efficiency cyclone.
Steel blast furnace	Varied	High efficiency	Electrostatic precipitator.
Basic oxygen steel-making.	Varied	High efficiency scrubber.	Electrostatic precipitator.
Cement kiln	Fine to medium	Electrostatic precipitator.	High efficiency cyclone.
Ferrous cupola	Varied	High efficiency scrubber.	Fabric filter.
Metal grinding	Coarse	Cyclone	Scrubber or fabric filter.
Wood sanding	Fine	Fabric filter	High efficiency cyclone.
Acid mists	Fine	High efficiency scrubber.	Electrostatic precipitator.

controlled. Note that in four cases the control equipment costs as much as or more than, the basic process equipment.

According to Professor Linsky of West Virginia University, the cleanest cement-making plant may cost 10 percent more than the basic capital cost; the cost of the cleanest integrated steel mill, 3 to 5 percent extra; the cleanest foundry milt shop, 15 to 20 percent extra; and the cleanest refinery 1 to 1.5 percent extra. As pollution control legislation becomes more strict on particle size and volume of emissions, I suspect that these extra percentage costs will go up.

To back up these cost evaluations, let me describe the air pollution control installation at a new edible-oil-processing plant of Darling and Company, Chicago, Illinois. It's a small plant, 16,300 square feet, and cost a million dollars to build. Of this, $65,000 or 6½ percent was spent on air pollution control equipment. The process consists of grinding and cooking meats and fat products to free the oil (Figure 1).

There are two ventilation and air pollution control problems; (1) control of water vapor from the bank of steam-jacketed cookers, and (2) control of odors. To prevent pollution, the water vapor is condensed and passed through a waste-oil trap before discharge to the sewer. Any cooker vapors not condensed are passed through a roof-mounted, gas-fired furnace. A direct flame which exceeds 1200° F incinerates any fat-frying odor that might have been produced.

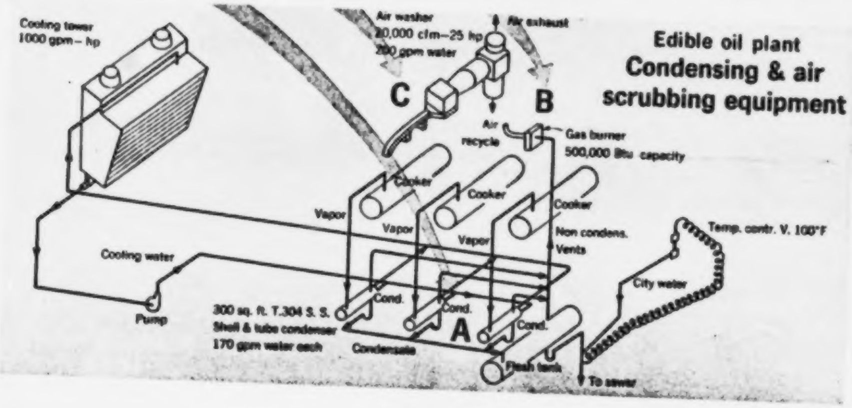

Cooling tower
1000 gpm – hp
Air washer
20,000 cfm–25 hp
200 gpm water
Air exhaust
Edible oil plant
Condensing & air
scrubbing equipment
C
B
Air
recycle
Gas burner
500,000 Btu capacity
Cooker
Cooker
Cooker
Vapor
Vapor
Vapor
Non condens.
Vents
Temp. contr. V. 100°F
Cooling water
City water
Cond.
Cond.
Cond.
Pump
300 sq. ft. T.304 S. S.
Shell & tube condenser
170 gpm water each
A
Condensate
Flash tank
To sewer

FIGURE 1

TABLE II.—*Pollution control selection*

Features	Wet (high efficiency scrubbers)	Dry (electrostatic precipitators)
Particle size	Takes more energy to separate fine particles from coarse particles.	Collects fine particles as readily as coarse particles.
Nature of solids	Preferable if dust is highly resistant and conditioning is not convenient.	Needs preconditioning with moisture if dust has high resistance.
Nature of gas or gas/solids mixture.	No explosion problem	Not used if gas or mixture may be explosive.
Gas volume	Takes less space than precipitator for small volumes, more space for very large volumes.	Practical if gas volume is high, especially if loading low.
Disposal of collected solids.	Needs equipment to separate solid in liquid particles from gas stream.	Draw directly from hopper and haul away.
Capital cost	Lower than precipitator except for very high volumes or low solid loading per cubic foot of gas.	Usually higher than scrubbers.
Operating cost	Higher than precipitator unless pressure drop is available from process.	Lower than scrubbers.
Maintenance	Lower than precipitator, except corrosion and abrasion if neglected.	Low, as there are no moving parts.
Power requirements	Relatively high if fans are needed for pressure drop.	Low. Precipitator acts on solids only, not on entire gas stream.
Heat recovery from effluent.	Preferred if liquid to be heated is in basic process anyway.	Preferred if heat recovery is desired from clean gas.

TABLE III.—*Pollution control cost data*

Source	Size of base equipment	Type of control equipment	Cost of control equipment as percent of base equipment cost
Carbon black plant	2,000 gallons per day	Baghouse	100
Chrome plating	4 x 5 x 5 feet	Scrubber	40
Coffee roaster	3 tons per hour	Cyclone and afterburner	23
Concrete batching	900,000 pounds per hour	Baghouse	8
Core oven	8 x 8 x 12 feet	Afterburner	37
Cupola, gray iron	4-foot inside diameter	Baghouse and quench tank	168
Deep fat fryer, food	1000 pounds per hour	Afterburner	10
Electric arc furnace, steel	10 tons heat	Baghouse	60
Fluid catalytic cracker	7400 barrels per day	Precipitator, vapor manifold and flare.	8
Grit blasting machine	6 cubic feet	Baghouse	18
Open hearth furnace, steel	60 tons heat	Electrostatic precipitator	75
Pipe coating	4 to 10 lengths per hour	Scrubbers	140
Pot furnace	16,000 pounds	Contract condenser and afterburner.	33
Rendering cooker and drier	4 tons per batch	Surface condenser and afterburner.	150
Rubber Banbury mixer	1000 pounds per hour	Baghouse	12
Synthetic rubber manufacturing.	30,000 tons per year	Vapor manifold and flare	16

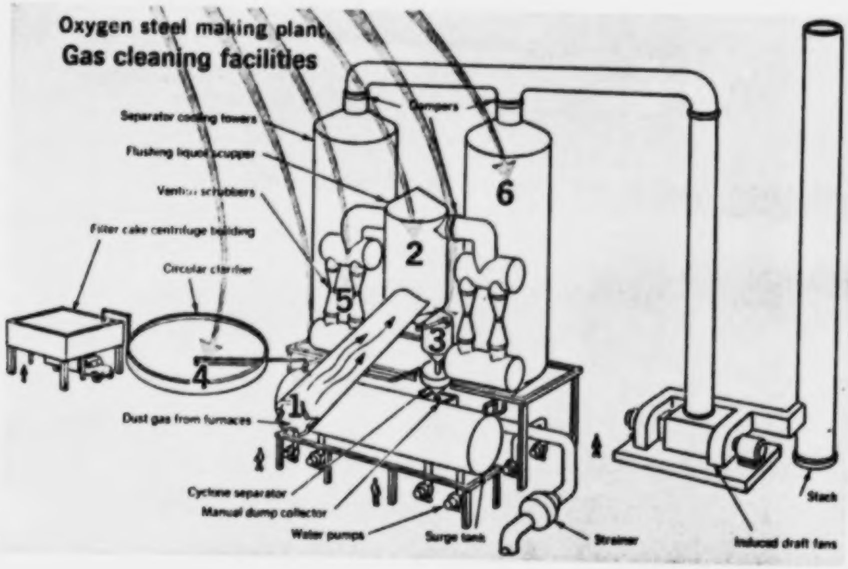

Oxygen steel making plant
Gas cleaning facilities
Separator cooling towers
Flushing liquor scupper
Venturi scrubbers
Filter cake centrifuge building
Circular clarifier
Dampers
1
2
3
4
5
6
Dust gas from furnaces
Cyclone separator
Manual dump collector
Water pumps
Surge tank
Strainer
Induced draft fans
Stack

FIGURE 2

To prevent air from escaping before purification, the entire building is maintained under a slight negative pressure. And for future precautions, the air-scrubbing system has been designed so that purifying chemical additives can be injected into the scrubbing water.

Advances in manufacturing technology are causing more critical air pollution problems. Let's look at steelmaking. The shift from open-hearth to oxygen steelmaking and continuous costing operations will create tremendous volumes of hot, dust-laden gases. The magnitude of iron-oxide emissions will be five times that of the old open hearths. Figure 2 shows the gas-cleaning facilities at the Gary Works of U.S. Steel Corporation.

When a metal bath in a vessel is blown with oxygen, hot dust-laden gases are collected in a water-cooled hood, then directed to the gas-cleaning facility. Cooled waste gases enter the pollution-cleaning plant through a main duct at (1). A stream of effluent water flows along the bottom of the main to wash large particles to the scupper. (2) Water and solids here are piped to a stationary screen, where particles ½ in. or larger will be removed. Further settling of large particles takes place in a callow cone. (3) Solids will be continually drawn off from the bottom of the cone and pumped as slurry to a 60 ft. diameter clarifier and thickened. (4) Overflow water from clarifier will be recirculated back to main after passing through gas-cooling towers.

From the top of the scupper, gases laden with fine particles will be pulled through narrow-throat venturi scrubbers. (5) Intense water sprays at each set of units will wash out the particles. There will be a separator for each set of venturis. By connecting the two separators in parallel, each will process half of the waste gas. This will permit periodic maintenance of one line of equipment at a time without completely shutting down the cleaning works.

Now, that ugly word "maintenance" comes up. Let me briefly describe the tale of another U.S. Steel installation at the National Works, McKeesport, Pa. This was the first venturi-type cleaner for sintering plant gases. Essentially this was a case of "the operation was a success but the patient almost died."

The details were fully described by E. R. Harris, chief engineer and F. R. Beiser, Division Superintendent Maintenance, in the APCA Journal, February 1965:

The installation was a success from the standpoint of meeting legal air pollution requirements, but many critical problems developed almost immediately in the area of maintenance of the new facility. The fan rotor and housing, sludge pumps and other parts of the system showed excessive wear to the point of failure within a comparative few days, despite excessive use of stainless steel and rubber linings."

Further, they stated that there were many questions "as yet unanswered." Let me bring you up to date on this one. Excessive wear was caused by erosion from the high-velocity abrasive action of dust-laden water and the corrosive action of acid in the system. Initially the fan failed after 8 days operation. Redesign resulted in beefed up section and new shape of fan blades as well as changing to stainless steel. Also a 90° elbow was inserted in the water stream to help pull abrasive solids out by inertia and divert the water to a separate clarifier. Besides the improved blade design, a ½" thick stainless steel reinforcing plate was added and the fan housing considerably strengthened. This was also done to reduce excessive noise.

The latest current report from U.S. Steel indicates that the system must be shut down every 60 to 90 days for periodic maintenance. This includes building up worn fan blades with layers of stainless steel and rebalancing. This maintenance headache started three years ago. Again, the point is that the pollutants are controlled only as long as the system is operating. Excessive downtime, caused by poor design or lack of experience in new areas, prevents proper continuous air pollution control.

This is only one case, but there are many others of long, tortuous installation startups. We in the American Institute of Plant Engineers sensed there were problems in the operation and maintenance of industrial air pollution equipment. For this reason, AIPE's Industrial Pollution Committee initiated a series of surveys to point out these problems.

Phase I was a pilot or sampling conducted among the 85 AIPE Industrial Pollution Committee men spread throughout the country. Phase II is currently being conducted among the entire 3,300 members of our Society and Phase III will be conducted among approximately 40,000 to 50,000 plants in the United States.

The results of Phase I or the pilot survey are in. All responses received represented plant facilities over 200,000 square feet. All plant engineers answering the survey were directly responsible for the operation and maintenance of air pollution abatement equipment in their plants.

Even though this AIPE report was a small sampling, the results clearly point out that: (1) design improvements are needed in such areas as collected wastes, operating costs, and better materials for equipment fabrication and specific industrial air pollutants; and (2) Government agencies are not too helpful in advising plants on practical pollution problems. In quick bulletin fashion, here are the highlights from the Phase I survey:

1. Twenty-five different types of industrial air pollutants and their sources were reported. Those reported most frequently were: (1) boilerhouse smoke and fly ash, (2) acid fumes from plating operations, (3) overspray from paint booths, (4) grinder dust, and (5) chemical process odors and dust.

2. There were 3 to 4 industrial air pollutants on the average from each plant. Of those reporting, 43 percent have pollutants *under control*, 25 percent have *planned controls*, and 32 percent have *no controls*.

3. In answer to the question, "Who has been most helpful in air pollution control for your plant?" both "staff specialists" and "consultants" were rated highest in aid. Some mentioned "county aid," a "trade association," and an "equipment manufacturer." No score was recorded under "Federal, State or city agencies."

4. In answer to the question, "Does your maintenance procedure differ from that recommended by equipment manufacturers?"—17 percent differ, 48 percent same as recommended, and 35 percent did not answer.

5. In response to yearly cost of operation and maintenance, many showed unusually high costs for waste disposal, KW power, natural gas, and maintenance labor. Some yearly costs exceeded 25 percent of total first cost plus installation cost.

6. For one particular brand of dust collector, the failure or breakdown rate averaged 9 times per year, resulting in 14.4

hours of downtime per breakdown. For a particular new scrubber installation one plant engineer reported $33,600 spent on maintenance labor cost so far this year.

7. Under *"need for equipment design improvements,"* note the following quotations. "Improve collection of sludge from scrubbers." "Cloth bag collections on tumbling dust burned up almost every year at a cost of $2,000/year." Since concrete sides in separator are corroding badly, we shall have to install a protective coating or lining in the near future." "Better disposal of collected wastes."

8. Under *"unsolved air pollution problems"* note these quotations: "Bag-type collectors discharge excessive dirt." "Iron oxide from rotary kiln." "Fumes from openhearth when decarbonizing." "Have many dust sources—need time and money."

Of course, AIPE is not the only society or association working on industrial air pollution; ASME, Manufacturing Chemists' Association, American Petroleum Institute, TAPPI, IGCI, and APCA, to mention a few, are also engaged. APCA's TA–5 committees are very active. These are the technical advisory committees of APCA.

The *Mechanical Dust Collector Selection and Performance Evaluation Guide* is in final draft form. It will consist of a nine-item specification, a five-point guide for "suitable and economical choice of equipment, and a procedure for evaluating performance." Mr. A. A. Peterson of UOP Air Correction Division, South Norwalk, Connecticut is this committee's chairman.

Another APCA committee under A. B. Walker of Research-Cottrell has developed similar specification and performance guides for dust, fumes, mist, and fog collectors.

And a third subcommittee under L. S. Harris, Schutte and Koerting Company, Cornwells Heights, Pa., has completed a preliminary draft on *Wet Scrubber Evaluation and Performance*. Each of the three is aimed at proper evaluation of equipment by competitive bids and the proper evaluation of performance under actual operating conditions.

How many here saw the CBS–TV hour-long show last September called "Poisoned Air?" If you recall, about half-way through the program a Ford vice-president was interviewed about automobile exhaust pollution. Immediately after this interview, the TV cameras panned the exterior of a Ford plant showing smoke belching out of stacks. And there was no comment from the narrator. To me this was a low blow and poor suggestive reporting.

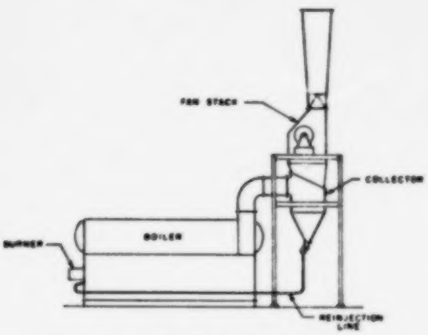
First of all, auto-exhaust pollution has no relation to plant air pollution. Second, the program obviously played on the emotions of the viewing public. The program picked on one case showing the worst condition but did not show any constructive action going on in the auto industry. Well, I'd like to straighten the record out.

Let's take the same company, Ford, again. In Cleveland, Ford's foundry is rated as the cleanest foundry in the world. They have spent an average of $800,000 per cupola for air pollution control. At Ford's Dearborn Specialty Foundry there are six similar installations. There are two major cupola installations under control at Ford's Canadian Foundry. Lately, installations have been made incorporating design improvements which guarantee removal of all particulate matter down to 0.05-micron particle size under the heaviest inlet loading possible.

Conservatively, Ford has spent well over $10 million on air pollution controls. Not to be outdone, the Chevrolet plant in Tonawanda, New York, has recently installed Centri-Spray air-wash equipment. According to tests made by the New York State Health Department, the air exhausted from this filter system is cleaner inside the plant than the normal atmosphere outside the plant. I have traced these cases to point out that reporting should include both the good and the bad side of air pollution.

What about Rule 66 in Los Angeles County? This is the new rule to control organic solvent emissions into the atmosphere. I received a report dated October 4, 1966, from R. G. Reichmann, Chairman, Ad Hoc Sub Committee of the Aerospace Industries Association. In a nutshell, his committee has worked closely with paint companies and the L.A. Air Pollution Control District to clarify Rule 66 and make it more practical.

But according to Mr. Reichmann, the Aerospace Industries are still faced with two big problems. His report stresses the need for investigation into solvent control equipment that will perform to the specified efficiencies called for by Rule 66. And second, solvent formulations that must be changed, particularly those covered by military specifications, must be extensively tested prior to submission to the Government for specification changes.



COLLECTION OF OIL FIRED ASH

FIGURE 3

All this takes time. The new rule is now in effect with deadlines for conformance. Further, states Mr. Reichmann, "In the event this cannot be done within the prescribed time limit, the only alternative is the use of unproven and expensive vapor-recovery control equipment."

To me this means that rules and regulations are being passed faster than equipment can be designed to comply—or rules are being passed without thinking about practical solutions to the problems. Wouldn't it be odd if a delayed change of Mil Spec on a solvent holds up NASA or military supplies bound for Vietnam?

Let me shift to the campus of Brown University, Providence, Rhode Island, A. P. Dieffenbach, Manager, Department of Buildings and Grounds, reports on the dust-collecting system of Brown's oil-fired boilers. The system consists of multiple-cyclone collectors from UOP Air Correction Division and includes a reinjection system. This reinjection system (Figure 3) feeds the normal oil fly ash back into the boiler.

The fly ash is 90 percent combustible and increases the BTU's. This results in raising boiler efficiency by ½ to 1 percent. Also oil-fired ash is high in sulfur content. The ash tends to plastic out below 350° F through the whole collector system.

This means excessively high maintenance caused by the fly-ash build-up. The reinjection system not only keeps the sulfur-bearing fly ash out of the atmosphere but also helps reduce the maintenance throughout the system. Projected payoff for the reinjection system based on improved boiler efficiency will be 1½ years.

Gentlemen, I've flown around the base-paths pretty fast this morning, but I mean to close by getting up on a soap box. Besides the need for proper enforcement of regulations, the often-heard cry is the need for money to install abatement equipment and research for better design of equipment. Where is the money going to come from? In water pollution control, industry can tie in with a municipal treatment plant that may be subsidized with Government funds. But air pollution is a purely individual plant problem.

There is no possible tie-in. If a company is strapped for funds, it's in trouble. You can't apply for a grant from the Government as public funds for private industry are frowned upon. Why not a private non-profit "March on Pollution" Fund that could make money available to industry on a long-term, low-interest-rate loan basis and also sponsor equipment-design research that normally would not qualify under Government research-grant procedures.

And where can the "March on Pollution" Fund generate its money? According to the Federal income tax reports, the American public and corporate enterprises claim over $8 billion in charitable deductions each year. The total air and water pollution control cost per year is estimated at $6.7 billion. Would it be possible to tap part of this $8 billion that goes for charity to prevent population deaths from air pollution?

". . . headed chemical engineering at Kansas State College . . . deputy director, War Production Board . . . director of developmental engineering, Corn Products Refining Co. . . . chief engineer, Air Pollution Foundation . . ."

AIR POLLUTION CRITERIA FOR INDUSTRIAL PLANT SITE SELECTION

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Traditionally, the general location of an industrial manufacturing enterprise is governed by raw material supply, closeness to markets, availability of fuel and labor, power and water supply, and factors of that sort. The specific site for the plant is selected with the idea of optimizing these factors.

Several examples come to mind. The extractive industries generally must locate near the source of raw material because the cost of shipping the product is much less than that of shipping the raw material, which, as a rule, has a very low bulk-value. For instance, a primary copper or zinc smelter locates near the mine. The phosphate industry, as a further example, is located largely in Florida and Idaho, so that it can be near the source of the raw material, phosphate rock. Of course, if cheap transportation is available—and by cheap transportation I usually mean transportation by water, by ship or by barge—then an industry which is oriented towards the raw material may move somewhat closer to the market and still not have excess costs of getting the raw material into his plant.

Most small industrial operations, like iron foundries, dry cleaners, things of this sort, are oriented toward the market, therefore locate near the market. Similarly, when raw materials are widely available, such as in cement manufacture, then the market also becomes a major factor in plant location.

Sometimes several factors are equal in importance. For instance, the steel industry located around Chicago because it could get iron ore shipped from Minnesota very cheaply through the lakes; there were nearby sources of coal, large sources of coal, and of course there was, and is, a large regional market for steel.

In the electrochemical industry, the cost and availability of electric power are extremely important factors in plant location. One of the reasons that the electrochemical industry settled around places like Niagara Falls and at Henderson, Nevada, near Hoover Dam, was the presence of cheap hydroelectric power. Of course, now steam-electric power is becoming more competitive so you have a little wider choice in plant location.

These traditional basic factors are still governing under our present economic system, but specific site selection within a given area must consider many secondary factors, among which air pollution considerations are becoming more important.

The primary factors are still overriding, however. Take a case or two in point. For instance, the American economy requires that some foreign ores, foreign crude oil, and other foreign raw materials, be processed in the United States. To process these raw materials, economically, they must be delivered cheaply by ship or by tanker, so the plant has to be located on or near a deep-water harbor.

From an air pollution standpoint, it may be that an inland site would be preferable, but for competitive reasons the choice can only be among several water-edge sites. The choice among these several sites may, of course, well be governed by air pollution considerations.

Another example is the pulp mill. The process requires large quantities of fresh water and a ready delivery of logs. So again a water-edge site, a river-edge site, if you wish, is necessary. And the specific river-edge site may, in turn, be governed by air pollution considerations.

Let us now look at the various factors involved in optimizing a plant site from an air pollution standpoint. The more important factors are meteorology, topography, the neighborhood, the nature of regulatory laws, and the attitude of the public.

METEOROLOGY AND TOPOGRAPHY

It seems almost redundant to discuss meteorology with regard to air pollution inasmuch as the dispersive ability of the air, or more properly, the lack of dispersive ability, contributes most to air pollution potential. Nearly every site suitable for an industrial plant is blessed with a dispersive atmosphere most of the time, so it isn't the usual situation which is most important.

It is, rather, the occasional periods when air movement is minimal, either in a vertical direction (because of an inversion or stable lapse rate) or in a horizontal direction (because of low wind speed). The frequency, intensity, and duration of these conditions are important factors in determining the suitability of a plant site. Accordingly, the more information one has concerning these meteorological factors or conditions in a given location, the more astute he can be in site selection.

In many localities meteorological records are available showing wind velocity and direction, temperature, humidity, precipitation, cloud cover, etc., for an adequate number of years. More often than not, the recordings are made several miles away, so judgment must be used in adapting them for a specific site. Information on inversions is scarce unless it's available from a nearby airport. But even when available only from rather distant points, useful information can be derived from it.

The utility of meteorological information depends upon how one evaluates it. Conditions suitable for one plant might well be very poor for another. For instance, a high frequency of low-lying inversions should discourage plants with ground-level emissions. But other plants for which elevated stacks may be utilized can take advantage of the inversions to prevent high concentrations of pollutants.

One is always tempted to generalize concerning favorable meteorological conditions and in fact, one commonly hears the statement that all plants should be built on windy hills downwind from the nearest city. But in some cases maximum downwind pollution occurs under high wind conditions, particularly if you are putting out large particles.

Further, the lee side of a hill can cause a plume to dip lower than it would dip otherwise, and thus bring pollution closer to the ground. Then when the wind stops, drainage flow down the hill, if you are downwind from the city, for instance, may result in high ground concentrations toward the normally upwind city.

The point to be made is that meteorological considerations are extremely important in industrial-plant site selection but that generalizations concerning the effect of meteorology are dangerous. Each case must be considered separately.

Topography is important because it has an ameliorating effect on meteorological variables. Everything else being equal, it is likely that relatively high terrain is the most suitable site for an industrial plant. The most likely spot for trouble is a highly populated deep valley. Even in a deep valley of low population density, channeling of pollutants may be a problem.

The channeling effect, particularly at night when we say "the air is heavy," is also a problem in many river locations. One should not conclude, however, that valley and river sites are not suitable for industry. They are, but usually considerably better emission control is required than for other types of terrain.

THE NEIGHBORHOOD

Just as meteorology is an important factor in site selection because plant emissions are discharged into the atmosphere, the neighborhood is important because it consists of the receptors of any pollution reaching it via the atmosphere. The common receptors, of course, are people, vegetation, animals, and inanimate property. Reactions of the receptors vary with the nature of the pollutant and the concentration of the emissions. Both are important.

Obviously, wherever people are involved, pollutant concentrations that affect health and well-being must be avoided, and they usually are. And although fear of adverse health effects is often used as the reason for opposing construction of a plant on a specific site, the real reasons are more likely to be fear of odor and dust nuisances, damage to property, and even esthetic considerations.

These fears will vary, depending on the nature of the neighborhood, whether it be residential, commercial, industrial, agricultural, or recreational. Dust and odor emissions that are not objectionable in an industrial community may be highly objectionable in a residential area and a source of great emotion in a recreational area.

A location near a residential community may require greatly curtailed emissions, or higher stacks, or a longer distance from your operation to your own property line in order to keep from being a nuisance. And if the site is near an airport, of course, the height of the stacks may be limited by law.

Obviously, if a site under consideration is in an agricultural area, the nature of the agricultural crop is highly important. Concentrations of sulfur dioxide that will injure cotton will have no effect whatsoever on field corn.

Another neighborhood consideration of importance is the nature of the industry or community already in the area, and this consideration works both ways. Not only must you not pollute your neighbor, but also he must not pollute you. Consequently, heavy industry usually settles in an area zoned for heavy industry, light manufacturing in another area, and so forth.

Zoning regulations, however, cannot be used as the sole criteria for the suitability of a plant site. In only a very few cases do zoning commissions have adequate knowledge to zone on an air pollution basis. It may be that the atmosphere in a given area has a background concentration of a given pollutant sufficiently high that an added load may create problems. Thus, to add an additional amount of sulfur dioxide to an atmosphere already suspected of having undesirable concentrations of sulfur dioxide is, at the least, imprudent.

Similarly, the release of ammonia into an atmosphere carrying hydrogen chloride will obviously cause a visibility problem to develop. Or again, to release large quantities of smoke into a valley noted for its exceptional view is to invite trouble. As would the establishment of a stockyard next to a motel, whereas the stockyard in an industrial area would be acceptable.

So, before selecting a plant site, one should look closely at the nature of the neighborhood and the quality of the air therein.

THE NATURE OF REGULATORY RULES

From time to time one hears of a manufacturer becoming aware of restrictive air pollution control laws only after the site has been purchased and construction has begun. Sympathy shouldn't be wasted on him because one of the primary rules of site selection is to know the legal situation in the area.

A more common occurrence is for industry to go into an area where there are no air pollution control regulations, and then suddenly to face new legislation. We can expect more of this in the future, so considerable care must be taken when purchasing sites in such localities. Certainly the assurance of an alderman or a development commissioner that restrictive regulations will not be forthcoming is inadequate assurance.

The astute manufacturer locating in an uncontrolled area will install controls adequate for the site, the surrounding neighborhood, and adverse atmospheric conditions. Further, he will have monitored the air in the vicinity for at least a year before his plant goes into operation. He will then be in a position to know what effect his emissions have on the locality and be able to prove it.

Inasmush as unknowns always exist where no regulatory agency exists, many industrial concerns prefer to build in an area where adequate air pollution control regulations are already in existence and where the control agency has a capable and stable staff. In such a community, one knows the rules of the game and can plan with some certainty.

Factors which lend further confidence in the stability of regulations are fair enforcement and minimum use of variance procedures. Where large numbers of variances must be granted, there must be something wrong with the basic regulations, and sooner or later problems will arise. If enforcement is lax, it can soon arouse public resentment and result in unjust and unreasonable legislation.

Industry should also avoid localities where air pollution is a political football. When the tides of politics change, one can suddenly be out of favor. The air pollution control agency cannot be stable when its head and other officers are political appointees. An independent and adequately financed control agency can be a boon to reasonable air pollution control, and industry is attracted to such areas.

ATTITUDE OF THE PUBLIC

Closely related to the efficiency and integrity of the control agency is the attitude of the public. A sound agency in which the public can have confidence is a real balance wheel in a community. Thus, management of a proposed plant can evaluate the stability of a community by investigating the attitude of the public toward the control agency. If the control agency is adequate, the public will have confidence in its decisions and industry can work directly with the control agency.

Where no control agency exists, it usually falls upon the industrial community to educate the public as to the facts with respect to air pollution. This may be a difficult chore. Any new industry is suspect to some segments of the community, who will oppose industrial expansion under the banner of air pollution even though other reasons are the real ones.

The only recourse is to educate the public so that an intelligent decision can be made. In some areas the public may already be on an emotional spree with regard to air pollution and its control. Here education may be an extremely difficult job and that fact may well influence site selection.

OPTIMIZING THE SITE

One can optimize an industrial site by many different permutations and combinations of the factors that I have discussed, because no two sites are exactly alike and few plants are alike in all respects. In some areas, meteorological factors are all-important; in others, the nature of the community or the status of control regulations is the governing factor.

The goal of the optimization procedure is to select a site that will allow acceptable air to be retained at the lowest cost to the community. This doesn't mean that all data can be put into a computer, and an optimum pollution control system obtained for a given site by pressing a button. There are too many value judgments, engineering judgments, and other qualitative procedures involved.

In the final analysis, the solution must be accepted by reasonable people who make up the great majority of the public. That is why I have included the public attitude as an important citerion in plant site selection. The best site in the world is no good unless the public accepts it.

A CONGRESSIONAL VIEW OF THE PROBLEM

J. CALEB BOGGS
U.S. Senator from Delaware

I am very happy to participate today in this significant Conference, and I also appreciate having the opportunity to listen to experts in the field of air pollution.

This Conference represents a great deal of work by the Department of Health, Education, and Welfare as well as a cooperative and helpful spirit on the part of those who are contributing to it. You are certainly all to be congratulated.

My own interest in the problem of air pollution is of long standing. Nearly 10 years ago, when it was my privilege to be Governor of the State of Delaware, we enacted our first air pollution control law. It was needed then, but the urgency today, of course, is much greater.

In 1962, the Senate Committee on Public Works created a Subcommittee on Air and Water Pollution and I have been a member since then. The experience has given me the opportunity to hear and learn a great deal about air pollution from Government officials, leaders of business and industry, scientists, and many interested citizens.

Our first major accomplishment as a subcommittee was the spadework which led to the passage of the Clean Air Act of 1963. It has since been amended, and I am encouraged by the progress which has been made under this legislation.

It was intended to provide significant new opportunities for government and industry to join in a concerted attack on the very serious threat of air pollution. Those opportunities are being met. But there is much more to be done, of course. This explains, at least in part, our presence here today.

Any consideration of the air pollution problem and legislation must be made in the context of the concern of the general public. I don't have to tell you that that concern is great, and seems to be growing. The "smog alert" along the East Coast recently called special attention to the problem.

Also, as you know, newspapers, magazines, radio, and television have given increasingly intense coverage to air pollution and its smothering impact on health, property values, and the simple enjoyment of our homes and communities.

Today we have a public alarmed over air pollution in its many forms. And government, at all levels, is responsive to the need to take action.

Although this public interest, coupled with action by government and industry, has resulted in progress, it would be a mistake to assume that the problem is receding. Air pollution rises along with our population growth and the growth of our economy. We can make progress in attacking pollution, and yet in effect only mark time, because of these forces which constantly add to the problem.

This situation is illustrated by the fact that at the present time more than one half of the nation's population, nearly 200 million people, live on about one-tenth of the land area. By 1975 we can expect that three-fourths of some 235 million people will be living on this same land area.

In brief, more needs to be done. We must encourage a sense of urgency, I think. We are all affected—industry, government, and private citizens alike—and we must all cooperate in cleaning up the air upon which we depend for our very lives.

My intent today is to comment briefly on what this air pollution problem means to industry in terms of responsibility, costs, government action, and opportunity.

Everyone in the Nation contributes to air pollution to some degree, but industry is naturally singled out because it is often a conspicuous contributor. A smokestack belching pollutants is a beacon hard to miss.

An article in the *Harvard Business Review*[*] makes the observation that "industry, in the broad sense, is directly or indirectly responsible for well over half of all the air and water pollution now taking place."

Whatever the exact contribution, industry obviously is vitally concerned with both causing and correcting the problems. It is understandable that in the past spokesmen for industry were not alarmed about air pollution. Neither was the public. And government was also not very active in the field. But times have changed, and so should the attitudes of all concerned with air pollution.

Today is not the time to hear the suggestion that air pollution is, after all, "only a small price to pay" for continued economic growth and technical progress. It is not the time, probably, to suggest that "the wheels of industry will grind to a halt" if we continue to insist upon cleaner air. It is not the time to say that "control of air pollution comes pretty far down" on any list of priorities by public and private agencies.

What makes such suggestions unreasonable is the fact of $11 billion in economic losses every year from air pollution. And who can put a price on the irreparable injury to human health in the form of such diseases as emphysema and lung cancer?

It is unthinkable that a nation as wealthy and as technologically advanced as ours will continue to pay the heavy price of air pollution.

I know that industry is aware of its part in air pollution's cause and control and that industry wants, and is working hard, to meet its responsibilities.

What of costs? After all, control of air pollution is an added expense in the manufacturing process. A minute ago I used the $11 billion in annual economic losses for air pollution. This could be drastically reduced—perhaps by two-thirds—with the expenditure of approximately $3 billion a year in air pollution control. The techniques, I understand, are available to do the job.

Admittedly this is expressing a complicated problem in simplified terms, but the two figures indicate that an effective air pollution control program could pay for itself. A potential bonus would be both healthier and pleasanter living conditions for our citizens.

Although there are many technical problems to be overcome, it is also worth noting that industry itself can collect a bonus from air pollution control if it can devise ways to capture and use again the waste products involved in air pollution. And I know it is working hard and doing a good job in this direction. For example, burning coal and fuel oil releases some 23 million tons of sulfur dioxide every year. On the assumption that roughly half of the total amount can be recovered, about 5 million tons of elemental sulfur could be saved and used. At current prices, this would be worth about $125 million.

Capturing waste products, or simply controlling pollution more effectively, takes research. Better ways must be found to stop odors from pulp mills, dust from cement mills, plumes of iron oxides from steel mills, and other sources of pollution from our varied manufacturing processes.

Industry has stepped up its activities in the research field and will undoubtedly expand its efforts in the years ahead. And the Federal Government must also exercise greater responsibility in the research field.

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[*] Sept.–Oct. 1966.

Based on this research and the improved techniques developed, and with the assistance of the businesses themselves, the Federal Government should also help devise and suggest reasonable standards for industrial processes. This would be a valuable service to local and State air pollution control agencies.

As you know, the Clean Air Act basically provides increased Federal support for State and local programs.

I certainly support this concept. After all, pollution begins as a local problem, and the best place to stop it is at the source. Pollution from motor vehicles is a significant exception because cars and trucks cross State lines so easily.

It is a safe generalization, I believe, that industry also supports the concept of local and State action. And industry can strengthen this approach by seeking and backing adoption of equitable and effective control regulations in our cities and States.

There is another level of government which will probably be increasingly concerned with air pollution control, and that is groups of States united in compacts.

Such an arrangement has recently been suggested very vigorously for the greater Philadelphia area, which would include the northern part of Delaware. Whether or not this particular compact will come about I don't know, but it is apparent that air pollution is no respecter of State boundaries, and what one State does has a definite effect on its neighbors.

While the emphasis is now on action by local and State governments, with the Federal Government supplementing their efforts, the public could demand a shift to more direct Federal action if the results are not satisfactory.

Industry and private citizens can help local and State governments and I am sure they will. But if this support is not sufficient, if it appears that the air pollution problem is overwhelming local and State efforts, the role of the Federal Government will necessarily expand. I know that our subcommittee will continue to watch developments closely.

We have a problem. We also have an opportunity to do something about it. All of us share in this opportunity. The means either exist or can be found to lick air pollution. What is needed for success in this effort is a matching determination by government and industry, backed by private citizens, to make and keep our air clean.

We have all been a little late in recognizing the extent of the problem but, now that we do recognize it, there is no excuse for not doing something about it. This conference itself is evidence of our resolve and will undoubtedly spur action in a battle we certainly cannot afford to lose.

QUESTIONS AND COMMENTS

S. CHARLES ROTHMAN (*Environmental Engineering Consultant, Portland, Oregon*): In the development, promulgation, or adoption of air quality standards, and in industrial emission restrictions, what, if any, effort is being made toward relating these values with the performance capabilities (including collection and cleaning efficiency) of presently available commercial air-cleaning hardware?

LARSEN: Some of the pollutant control measures on the market, such as those for controlling particulates by bag-houses or electrostatic precipitators, are adequate. But there are some problem pollutants in the country with which we are just beginning to cope. One example is the nitrogen oxides that are produced whenever a fire is lit, whether in an automobile engine, at the end of a cigarette, or in a home furnace. Research is under way to control the nitrogen oxides, but the future does not look bright unless more promising techniques are found. In some cases, we may need to go to process changes. Instead of getting our power or heat from flames, in some cases we may need to go to alternative sources of power or heat, such as atomic power.

Other pollutants, such as the sulfur oxides need to be controlled at levels that we cannot presently achieve or that we cannot achieve economically. Present techniques for controlling sulfur oxides are fairly costly and are not widely used.

So, for some pollutants, such as the particulates, hardware is available for control. For some of the other pollutants, especially the gases, hardware is not available, although it is being developed. In some cases, process changes will be necessary.

HUGUET: Mr. Rothman's next question is similar to a comment from Joseph Waitkus, Manager of Industrial Sales Development of the Air Preheater Company, Inc., Wellsville, New York.

ROTHMAN: Why impose an unrealistic standard or restriction if the engineer does not have at his disposal for design purposes the proper equipment capable of meeting it?

WAITKUS: Is it not better to first establish a limit, such as in Rule 66, recognizing that it might be difficult to achieve? Equipment manufacturers now have some sort of guideline or goal to which to react. Equipment is now available that can meet Rule 66 requirements. My point is, establish the guideline, and equipment manufacturers will follow in due time with the controls necessary.

LUND: I was just reporting on what Chairman Reichmann had to say, but it was the feeling of his Aerospace Industries Association that Rule 66 was pretty far-reaching to take all at once. As for the other comment that there is equipment available and that the manufacturers will make the needed equipment available if they have guidelines to go by, there has been talk in the American Institute of Plant Engineers that there's a wide gulf between the stated equipment performance and what the actual sustained performance really is. The people in Chairman Reichmann's ad hoc committee are pretty worried about the efficiency of equipment that is currently available, although I understand that a different kind of equipment could possibly do a better job. The cost of some of this equipment, I think, should also be taken into account.

HUGUET: Mr. Rothman's third question is probably one that Dr. Larsen would comment on: "Is there any unified or coordinated research being done on the establishment of design criteria or benchmarks which the engineer might use as specification guidelines? Do you consider this an area in which the Federal Government might move?" I also have another comment from the floor which I would appreciate your discussing at the same time, if you can. This is from Theodore Pankowski of Detroit, Assistant Director, Department of Conservation and Resource Development, United Auto Workers International Union "Recognizing the urgency of our natural air pollution problem, I respectfully urge that the Conference Steering Committee initiate a series of regional conferences to recommend and discuss minimum standards, and enlist the support of all local officials, industry representatives, and citizens, in order to mobilize a united and immediate effort in this critical situation."

LARSEN: Several steps are needed to get from air quality measurements to meeting air quality goals. Some of these steps were mentioned in the presentation. In brief, we need pollutant concentration data for at least a year in various communities. We also need emission surveys, such as those that have been conducted in Louisville, Nashville, St. Louis, and other cities, to find out how much of each pollutant is coming from each source. Then we need information on the effects of pollutants on people, animals, plants, and property. This research is under way in Public Health Service laboratories and in other laboratories throughout the country.

Air quality criteria can be listed to indicate what effects would be expected at various pollutant concentrations and exposure durations. The first set of such criteria is being issued by the Public Health Service for the sulfur oxides, and should be available within the next few months. It will be followed by criteria for the oxidants. Criteria for the other pollutants, such as carbon monoxide and the nitrogen oxides, will come later.

This information on criteria allows a community to determine what effects they wish to prevent—odor or eye irritation or carboxyhemoglobin in the blood—and to select a value. Or they can ask for advice from State or Federal agencies.

This information can be used to calculate just how much reduction is necessary, and to determine emission standards. I have some ideas on what these might be. Several ambient air quality standards are listed in the literature. It's a very simple operation to determine emission standards from these. For many of the general air pollutants, about a 95 percent reduction would be needed in order to meet some of these air quality standards.

GEORGE S. CAMPBELL (*Campbell and Jones, Inc., Chattanooga, Tennessee*): What is the possibility of tax incentives to cooperating industry?

BOGGS: That's a very good question, and for the past several years there have been several members of the Congress, both in the House and in the Senate, who have made proposals for tax incentives for air and water pollution control assistance and encouragement. But I think that under present circumstances, with the temporary suspension of the investment tax credit, the possibility of any immediate legislation of this nature is not very bright. I would hope that, as soon as opportunity permits, these efforts will be renewed. I think such incentives would be very helpful in the overall fight.

CAMPBELL: I would appreciate comments as to the possible value of recovered pollutants which would tend to offset pollutant control costs.

FAITH: Let's face it, it costs money to recover any pollutant. When you take a solid material or a gas out of an exhaust stream, it costs money. You may, in turn, recover something which will have a value somewhere between zero and some larger number. But generally speaking, the cases in which you can make a profit on the recovery are very few. There may be more in the future, but I think that, on the whole, industry has to face the fact that it costs money to clean up the air.

HUGUET: I think that's very true. Earlier this morning, Dr. Larsen mentioned the approach of process modification. Sometimes, through process modification, you can prevent pollutants from escaping in the first place, and this sometimes does give you an overall operating economy.

E. F. PORTER, JR. (*Executive Secretary, Missouri Air Conservation Commission*): What is the prospect, in your opinion, that States will cooperate in regional control programs?

BOGGS: I think that under certain circumstances, regional control programs are helpful and desirable; I generally encourage the compact effort. In our little State of Delaware, with Pennsylvania and New Jersey and New York nearby, we have been very successful with a compact in which the Federal Government also participates as a sitting member on the Delaware River Basin Authority. In air pollution control, there is definitely an area for cooperation among the States, especially in the closely-knit, heavily-populated industrial situations. But I wouldn't want to see the States or the local communities just shifting their responsibilities to a regional authority. I wouldn't want the local and the State effort to be weakened or undermined. However, where there is a need for it, to supplement and strengthen the local or State effort, there are no doubt situations in the country where a compact between two or more States would be helpful and effective.

R. LEE BYERS (*Research Assistant, Center for Air Environment Studies, Penn State University*): You mentioned that industry received the least aid from State and local control agencies. In what way do you feel that control agencies should assist industry in the control problem?

LUND: I can only draw upon what I have seen around the country. To cite an example of what can be done, I refer you to the Chicago area, where I think a commendable job has been done with the least amount of publicity. The control agencies there work with industry, particularly with the small-to-medium type plant. They will conduct an inspection, go in and evaluate pollutants for a company. They have a diagram of the plant process; they will indicate where the pollutant sources are and suggest to the company what corrective measures can be taken. I understand that they also make available some preliminary design capability to help a small-to-medium firm get started on proper installation. If more agencies would take this approach, you'd find industry much more appreciative and responsive.

HUGUET: We have one question that has stumped the experts. I'm going to read it to the audience, and inquire if anyone has any information on this. This is from Floree J. Aquino, *Vice-Chairman of Pennsylvania Region III, Air Pollution Control Association, Beaver, Pennsylvania.* His question is: What solutions are there to control the emissions from brickyards?

ROTHMAN: This is somewhat related to the question I asked Mr. Lund. With respect to brickyards, there are a number of collectors available. Criteria for selection are the gas temperature of your effluents, particle size, and the corrosive characteristics of the dust.

There are certain cloth collectors available on the market. While I'm not plugging any of the synthetics, it may be necessary to use nylon, dacron, or some other synthetic because of the corrosion problem. This will also govern the selection of the cloth collector from the standpoint of temperature. There are certain cloths available for collectors that will take 500 degrees. Your chance of collectors depends also, as was pointed out, on particle size. If you do any grinding, any fine-particle compounding, you might have to go to an electrostatic precipitator. There are a number of publications available on this matter.

DAVID M. BENFORADO (*Manager, Direct-Flame Incinerators, Air Preheater Co., Wellsville, New York*): Regarding comments on Rule 66, the implication is that control equipment is unproven. Is it not true that the use of direct-flame incineration or afterburners with heat-recovery equipment is an improved method of meeting the requirements of Rule 66 with 99 to 100 percent efficiency?

LUND: This may be true, but the problem relates to size of equipment. In painting a four-engine aircraft, for example, there's quite a large volume of emissions. It's a question of whether or not the right-sized control equipment is on the market right now to handle this kind of problem. Your statement may be true, and maybe the information hasn't reached the West Coast yet.

DR. NORMAN J. WEINSTEIN (*Assistant Director, Princeton Chemical Research, Princeton, New Jersey*): The experiences described by Mr. Lund have been repeated in many plants. Poorly-designed control equipment is uncomfortably widespread. I would like to reinforce what Mr. Lund has suggested, that there is no substitute for good engineering in equipment design and specification.

I strongly recommend that engineering firms and consultants be used to systematically approach the pollution problems.

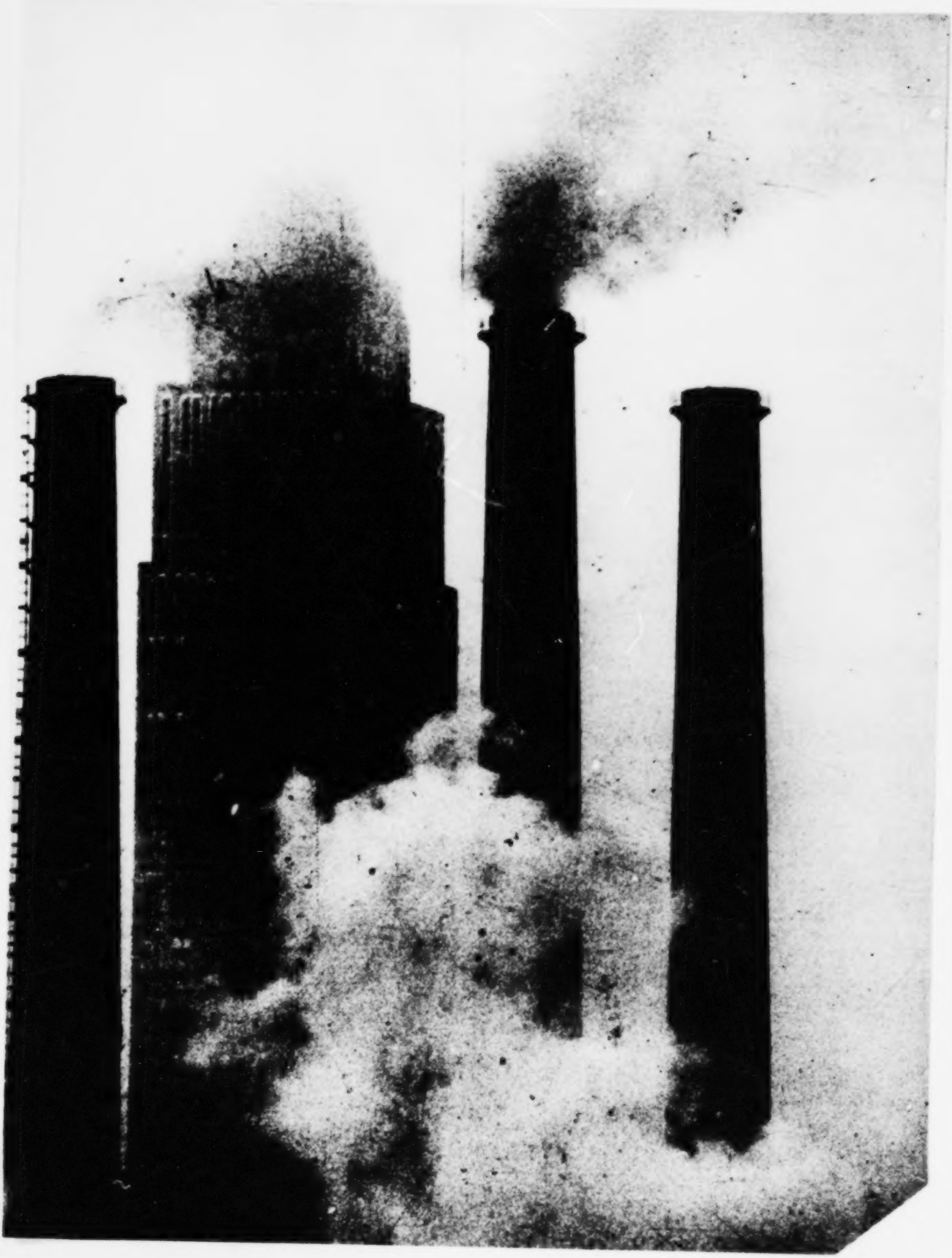
Occasionally, as has been suggested here, the proper selection of control equipment can even lead to economies through improved recovery. Mr. Lund cited the recyling of ash, the recovery of heating value. There are many examples of solvent recovery. There are reductions of losses in oil refineries that have often completely paid for control measures. The recovery of fine iron particles pays for the cost of control in many of the steel plants. Good engineering pays for itself in plant construction. It will also pay for itself in pollution control.

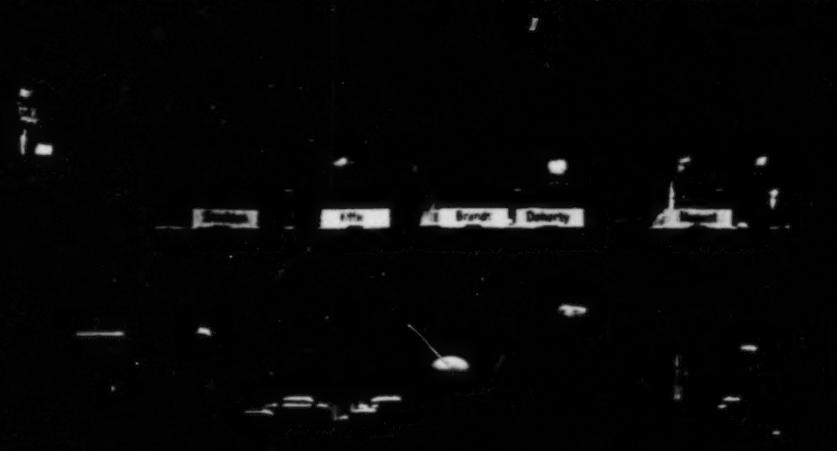
HUGUET: Before closing this session, I would like to make a further point. I was privileged to attend the First International Clean Air Congress, held in London. Although I was impressed by the excellent technical submissions, one thing seemed outstanding, to me and to a number of other attendees from the United States.

The Alkali Inspector of England, Frank Ireland, and his predecessor (the alkali inspectors are the control officials who deal with industrial air pollution problems) were very proud that, over the last 50 years, there have only been two cases when any type of legal action was taken against any industry in England. They have felt that the development of a very close cooperative government-industry program was essential.

They feel that they have achieved this type of relationship. They apparently feel that they haven't done their job right if they have to make a legal case out of it. While I'm not recommending that we throw out all legal or enforcement practices, I mention the British precedent as a goal which industry and government could hope to achieve here.

It is my sincere hope that the papers and discussions you have heard today, and will hear during the rest of this conference, will move us in that direction.





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December 13, 1966

PANEL C

INDUSTRIAL OPERATIONS

SECOND SESSION

Chairman Edward L. Stockton
Chief, Allegheny County Bureau
of Air Pollution Control
Pittsburgh, Pennsylvania

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". . . engineer . . . chief of bureau of environmental health, Allegheny County . . . housing consultant, World Health Organization . . . diplomate, American Academy of Sanitary Engineers . . ."

INTRODUCTORY STATEMENT

EDWARD L. STOCKTON
Chief, Allegheny County
Bureau of Air
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Pittsburgh, Pennsylvania

We will discuss this afternoon the current status and future prospects for control of pulp, steel, and cement mills; chemical plants; foundries; and refineries.

There is a general concept that present technology is adequate to provide control for the types of air contaminants which we will discuss this afternoon. Further, there is a general concept that all we have to do is spend the money and install the necessary particulate or gaseous control devices, and we can achieve the levels of control necessary. In addition, there is a public attitude that industry has the money to make these installations. Therefore, this reasoning goes, why don't control officials at all governmental levels get on with the job of enforcement to see that such controls are installed on industrial operations posthaste, to insure that emissions are brought down to meet air quality standards, and to prevent health hazards and property damage?

As one local control official in Pittsburgh and Allegheny County, with nearly two decades of control experience, I have seen a spectacular degree of successful control achieved in this urban steel center by the installation of available dust-control-type devices and process changes. Yet, essentially no control has been achieved over gaseous emissions. The improvement in Pittsburgh has largely been achieved through voluntary efforts in most instances, as opposed to enforcement actions. A code was enacted, but was used sparingly.

I would like to emphasize that much of the cleanup occurred as a result of process changes. Our experience has indicated that a major portion of our success has been attained by process changes, as opposed to installing control devices.

In Allegheny County, there has been an investment of approximately $400 million since World War II to provide cleaner air. Eighty-two million dollars of this was invested by home-owners to convert from solid fuels to gas space-heating.

Locomotives and river towboats were converted to diesels, which required an investment of around $200 million.

As a result of these and many other changes, there are about 20 million fewer tons of coal burned per year in Allegheny County now than in 1946, and the collection of soot and fly ash is no longer required for this quantity of coal.

The process of making steel has been modified in some instances by the abandonment of open-hearth furnaces and the substitution of basic-oxygen furnaces. You will hear more about this from one of our speakers this afternoon.

Once the dust materials have been captured in cleaning devices, there is a problem of what to do with the collected material. In some instances, steel dust lends itself to the sintering process whereby this very fine gritty material is made into clinkers to be used in the steel-making process. In the sintering process, portions of the very fine dusty material escape, and must be captured and collected once again in another cleaning device. This material is so fine that it acts almost like emery dust. Our experience indicates that it quickly grinds out valves on the collectors and causes other damage inside the collection units.

In other words, there is a very high maintenance factor on the collection devices in handling these materials.

Some collected materials must eventually be dumped. Fine particulate material from collectors and waste products, such as clay, present major disposal problems. To prevent these materials from becoming airborne contaminates during high winds, special covering techniques must be employed. Quite often, vegetation will not grow on these waste materials.

These examples should serve to indicate that a part of the solution to cleaner air is quite often a process change rather than the installation and maintenance of expensive cleaning devices. There is some evidence that even with sizable investments by industry, not all the factors are known about proper design of collection facilities. These unknown factors cause investments to be made, and sometimes all the collection devices are abandoned for failure to function satisfactorily.

There are examples in the Pittsburgh area of such facilities, costing on the order of one-half million dollars, having to be abandoned because engineering design considerations did not take all factors into account. Cleaners may have been adequate to remove dust, but temperatures were not reduced as anticipated by the time the hot gases entered the cleaner.

Changes in process operations, such as adding additional oxygen to a steel-making process after the collection device was installed, have also created problems.

Even though the collection devices may have been properly engineered for a specific job, there have later been excessive temperature or spark conditions which tend to damage the internal parts of the collection unit. This in turn has forced the abandonment of one such facility on top of a plant, and caused the erection of another collection facility at some distance from the plant, at the cost of another half million dollars. In one situation, this damage occurred less than six months after installation.

Experience in Pittsburgh further indicates that the cost of maintenance in operation of such facilities is quite high. There are many cleaners installed in Allegheny County on steel mills, cement plants, electric furnaces, sintering plants, powerplants, and other facilities. Our department has indicated that it costs in the neighborhood of 16 million a year to maintain those facilities which are presently installed.

Industrial firms have vigorously sought ways and means to utilize the captured materials from the collection devices, and to make these into salable byproducts. In some instances there has been a degree of success. Examples include the manufacture of cinder blocks from fly ash from powerplants, and the capture of certain chemicals in the coking operations which sometimes pay for the collection equipment in a relatively short period of time.

However, in many operations where no salable byproducts are collected, there is need for consideration of tax relief or other legislation to encourage industry to install more expeditiously the necessary cleaning devices.

Another process change in the Pittsburgh area, which offers a new approach to the capture and removal of SO_2, is worthy of note. A major coke works is being equipped with a new chemical process, known as a cryogenic plant, which will freeze out sulfur and other products from coke-oven gas. This particular plant is expected to remove over 120 tons of sulfur each day of the year.

Since this coke-oven gas is cleaned and piped to several steel-making plants downriver from the plant, it is significant not only that the gas will be cleaner, but also that this quantity of sulfur, which is presently being emitted into the atmosphere, will be removed from the atmosphere for a ten-mile stretch down the river as a result of a process change that involves the use coke-oven gas for fuel.

The coke-oven gas is an important source of fuel, and replaces coal, which might otherwise be used with a potential discharge of particulate matter and sulfur compounds. We are therefore pleased to see this major investment being made, not only to improve the emissions from this coke plant, but to see the benefits which will be derived in other steel mills as a result of sulfur and other products being removed at this plant. Unfortunately, the excessive cost of the plant and the nature of the chemical process are such that the process may not lend itself to the removal of SO_2 from other sources.

In another instance in Allegheny County, a firm equipped a cement plant with an electrostatic precipitator which removed 96 percent or better of the dust being discharged from the mill. However, the remaining 4 percent has created a nuisance problem in the community, and the firm is now erecting a new cleaning facility at a cost of an estimated $1 million to remove in excess of 96 percent of the material which would otherwise be discharged from the plant. This matter will be discussed further by another of our speakers this afternoon.

In 1960, industry and business leaders in Allegheny County undertook a "Renaissance Program" to clean up the air in Pittsburgh and Allegheny County. In the City of Pittsburgh, we have been successful in reducing the average dustfall emission per year from its former peak of 170 tons per square mile per month to 28 tons per square mile per month last year.

In the remainder of Allegheny County, where there are certain plants still not equipped with cleaners, the average dustfall for the whole county last year stood at 49 tons per square mile per month. Our monitoring equipment is located adjacent to the source of emissions and reflects a biased result, since it indicated maximum effluents.

Industry made an agreement with our Board of Health back in 1960 that they would provide cleaning devices on every facility by the end of 1970, or modify the facility so that it would comply with our rather strict requirements. At present, over 68 percent of some 80 open-hearth furnaces are so equipped. Over 53 percent of the electric furnaces are properly cleaned. All of the sintering plants are expected to be 100 percent cleaned by the end of this year.

This program of clean-up has been a success story, but in the areas where cleaners have not been provided, residents adjacent to the facilities involved are much displeased with the dust which continues to fall in their particular area.

With all of the attention which is being focused nationally on cleaner air, there is tremendous pressure to speed up the schedule and try to beat the 1970 deadline by installing cleaning devices at an earlier date than is now planned. This is certainly a desirable objective. Industry had been asked to consider whether it can expedite the schedule earlier than the planned completion date.

It should be pointed out that generally there is *at least* a two-year lead-time necessary to perform the necessary engineering, obtain approval of financing from top management, order the necessary materials, and install the cleaning devices. Experience to date indicates that in some instances manpower is not available to install such facilities at this speeded-up rate, regardless of how desirable this might be. At present, with the Vietnam situation taking manpower and materials, there have been slowdowns which have caused minor delays in meeting agreed-upon schedules. Unless the world situation improves, and both manpower and materials can be made available at a much faster rate, there are likely to be even longer delays in making the necessary installation of cleaning devices to provide adequately cleaned air.

It has further been our experience in Allegheny County that through the use of an advisory committee comprised of representatives from industry, business, and the community, there has been excellent cooperation between industry and government in attempting to find solutions to all aspects of air pollution control. This program includes such things as attempts to provide proper collection and disposal of solid wastes, cleanup of powerplants, maintaining scheduled installation of cleaners, research on unsolved problems, and other matters which are not germane to our discussion this afternoon.

This fact is cited only to indicate that the entire community is interested in cleaner air, and that industry is playing its role by making extensive investments and providing cleaning devices or process changes which have helped to make Pittsburgh a much cleaner place in which to live.

It is hoped that these introductory remarks will serve to indicate that it is possible to clean up the air through an aggressive air pollution control program. It is also hoped that these remarks will further help to indicate that technology is not adequate to meet some aspects of the problem, namely, control of gaseous emissions. Money is being put into research by both industry and government in an attempt to find some of these answers.

Except for very small industrial firms, where the control costs sometimes exceed the cost of the basic plant, it would appear that industry is both willing and able to provide the necessary controls to meet stipulated air quality standards. However, it is apparent to us that money, manpower, and materials are not always available to achieve clean air overnight.

My remarks concern one small area in Pennsylvania. Now let us turn to a discussion of the current status and future prospects for pollution control on a nationwide basis by the several kinds of industry which will be discussed during this afternoon's session.

". . . lawyer . . . W.W. II bomber pilot . . . served as counsel to Senate Labor Committee . . . N.Y. State award for pollution abatement . . . in charge of industrial relations for his company . . ."

CURRENT STATUS AND FUTURE PROSPECTS—PULP MILL AIR POLLUTION CONTROL

RALPH W. KITTLE
*Vice President,
International Paper
Company,
New York City*

International Paper Company welcomes the opportunity to participate in this significant National Conference on Air Pollution. Hopefully, through an exchange of views and problems, we can produce a blueprint for cooperation in a program for clean air.

The topic assigned to me is "Current Status and Future Prospects—Pulp Mill Air Pollution Control." While there are other types of pulping processes in the pulp and paper industry, the kraft process is by far the most significant in volume, accounting for more than 60 percent of total U.S. pulp production. Furthermore, it is in the kraft pulping process that we find the major air pollution problems specific to the paper industry, namely, the kraft mill odor and the discharge of dust-bearing flue gases. For these reasons, my remarks will be devoted principally to the kraft process.

In the kraft pulping process there are several different categories of emissions, issuing from different processes and susceptible to different treatments. Perhaps it would be helpful for me to preface my comments on the current status of our air pollution control efforts by identifying the various sources of these emissions.

The first general category of emissions is particulate matter, which is carried by some of our flue gases. The economics of the kraft process require the almost complete recirculation and reuse of the chemicals utilized in the process, as well as, where possible, the use of waste materials for energy. The combination of these several conditions results in the generation of large volumes of flue gases containing solid matter, technically termed particulates.

Among these particulates are fly ash, which results from the burning of the waste bark, sawdust, and other woody waste in steam generating boilers; recovery furnace stack dust, representing cooking chemicals lost from the process when the spent cooking liquors are burned to separate the organic materials dissolved from the wood from the inorganic cooking chemicals prior to their regeneration for reuse; and stack dust from the lime kilns, which results from the recovery of cooking liquors. In addition, wherever fossil fuels are used, there may be problems similar to those in other conventional boilers of this type.

The next category of emissions, water vapor-laden air vented from paper machine dryer hoods, does not contribute to air pollution, but simply adds moisture to the atmosphere. It merits mention merely because water vapor often makes a spectacular white plume over a paper mill, but it is a nonpollutant and is harmless.

A third category of kraft mill air emissions includes the noncondensable chemical components in the furnace flue gases. These flue gases contain sulfur dioxide in the cases of recovery furnace operations and of boilers fired with high sulfur fuels such as some coals and fuel oils. Those from the recovery furnace may also contain odorous reduced sulfur compounds. Except for the recovery problems of particulates which were referred to previously, the industry's flue gas problems are similar to those of most fuel burning operations, as for example those of conventional power-generating steam plants.

The last category of air emissions covers several sources of noncondensable gases from the pulping and chemical recovery processes. These gases are released from digesters, evaporators, dissolving tanks, lime kilns, and recausticizing units, all essential to the kraft process.

Having listed the four categories of emission from the kraft pulping process, I will now discuss the current status of their control, and the future prospects for improving the control of pulp mill air pollution.

In the area of particulate matter, the technology has been well established. Here, the paper industry has done its best job of air pollution control. Ninety-eight percent of the kraft mills in this industry have major collecting devices for particulate control. In fact, 60 percent of these mills employ collection devices designed for in excess of 97½ percent efficient recovery of furnace particulates. In past years, precipitators were usually installed for the purpose of achieving about 90 percent collection efficiency. Today, few new precipitators are ordered which have a designed collection efficiency of less than 97½ percent. Nearly $50 million has been spent by the industry to achieve this performance on recovery furnaces.

The equipment used to control these discharges includes cyclone collectors, electrostatic precipitators, venturi scrubbers, and other types of wet scrubbers. With the present application of that equipment and technology, it is estimated that, industry-wide, 90 percent of all possible particulate emission has been eliminated. To develop and apply the technology to bring us to a point even approaching 100 percent will probably be more expensive than it was to arrive at 90 percent control.

Passing over the water vapor vented from the paper machines as nonpollutant, we will now consider the control status of furnace flue gases of steam boilers. The problem here is one of fuel availability and money. To the extent that we burn fossil fuels, we share a comon problem with operators of other fuel burning equipment. However, the second category of furnace recovery flue gases, as well as other pulping process gases which constitute an odor problem, is not so easily definable, and remains the area with the greatest possibility for the development and application of new technology in this industry's air pollution abatement effort.

The odor problem is a difficult and elusive one, and the fact that it has resisted solution to date is not because a great deal of thought and effort has not already been devoted to it. The National Council for Stream Improvement, an organization supported by our industry to do research in air and water pollution problems, has conducted several research projects on air pollution abatement. Individual companies have tried countless methods of abating this odor. Universities have been commissioned to do research in this field. In other words, countless hours, considerable money, and many people have been involved with this problem. Complete solutions still elude us; yet we have made significant progress, and we are gaining a better understanding of the problems remaining to be solved.

It should be noted that the odor problem has been alleviated in recent years through the development of new technology, including a process known as black liquor oxidation, which reduces the emission of odorous compounds. By early 1969, over half of our mills will be utilizing this process. But let me emphasize this: the ultimate solution to the kraft-mill odor problem is still unknown. Incredible as it may sound, the odorous compounds in the kraft process, which include methyl mercaptans, are detectable by human beings in proportions as small as one part to one billion parts of air. This indicates the complexity of the problem which we are diligently working to solve.

The future prospects of the pulp and paper industry's air pollution control programs can be illustrated, I believe, by the increasing tempo of our expenditures and efforts in this area. Our industry has spent well over 75 million dollars for installation of air pollution abatement and control equipment, $30 million during the last four years. In the next four years, however, we expect to double this amount, to $60 million. From 1963, mill capacity increased 37 percent, but air pollution control investments by this industry jumped 61 percent. I want to make it clear that none of these figures include capital expenditures for process changes, which have served to minimize kraft air emissions, nor do they include the ever-increasing and continuing operational costs for any of this equipment.

Neither have we included in these expenditures the many ambient air monitoring programs now in effect. Over 60 percent of our mills now conduct such programs. Projected at the current rate of application, it is estimated that within the next three years these programs will be universal throughout the industry. By conducting these programs, we can better identify the areas where improvement is needed.

Let us now look for a moment into the future. What are the future prospects for the solution to our industry's major problems? And what do we propose to do about them?

At the State and local levels, the pulp and paper industry, along with other industries, is stressing closer coordination and participation in helping develop effective, realistic air management programs. In the State of South Carolina, as an example, the pulp and paper industry, along with other industries, is taking and has taken an active part in drafting an enlightened State air pollution control program with which both industry and the citizery can live and of which they can be proud. By such action, we can continue to help our State and local governments exercise responsible and effective control over their own environment. Our State and local governments know best their own land needs and uses, and through the identification of local air problems, by using the data available through industrial and municipal air studies, and by taking into account industrial and municipal locations and sizes, as well as local climatology, they can develop systems of air management suited to their needs and responsive to local air problems.

The future prospects within our industry for controlling kraft pulp mill air pollution depend on several considerations.

First, I believe that our industry must participate more actively in the identification of air quality goals. This involves our current ambient air monitoring programs. Further, it involves cooperation and encouragement of State and regional air quality programs.

Next, we must continue our research efforts to develop new technology and make further application of known technology as needed. Our company, along with others in this industry, on their own and in cooperation with our national council, can and will continue research in areas where new technology is required.

We must also recognize that time is a factor. As we continue our current air pollution control, time must be allotted for these efforts and for the development and expanded application of new or refined technology.

Summing up, it has often been said, but its truth is still applicable, that the byproducts of industrialization, which has brought us better and more diverse products at lower prices, have created some undesirable environmental problems. But as industrialization has passed along many benefits to society, sadly but truly, it has passed and must pass along to society some of its liabilities as well. When we speak of technological breakthroughs which are as yet largely unknown, we are speaking of tremendous sums of money. Society, through either the industrial producer and the ultimate consumer, or through the corporate and the individual taxpayers, one or the other or a combination of both, must share the burden of the basic and applied research for answers to problems, as well as the implementation of the technologies developed, all of which involve non-revenue-producing capital and non-product-oriented improvements.

As long as people breathe, the quality of our air must continue to be precious to each of us. While clean air exacts its price from us all, each of us must be willing to provide the time, money, and effort required to assure that each next breath will be as pleasant as it is necessary.

". . . responsible for environmental health engineering . . . noise, pollution, radiation protection . . . author of book on "Industrial Health Engineering" . . . chairman, Pennsylvania Air Pollution Commission . . ."

CURRENT STATUS AND FUTURE PROSPECTS—STEEL INDUSTRY AIR POLLUTION CONTROL

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While it is well known that steel making and processing require tremendous quantities of air, the exact amount per ton of steel products made is not known. There is little doubt, however, that the amount used exceeds the amount of steel made many times, even on a weight basis. Much of the air "used," of course, is not changed significantly in quality as a result of its use. On the other hand, many of the operations involved in steel making and processing do impair to some degree the quality of the air used.

Therefore, air pollution control equipment is now, and for many years has been, used extensively in the steel industry. The rate at which such equipment is being installed is accelerating rapidly in an effort to keep pace with the increased need as a result of the rapidly increasing rate at which air pollutants are being discharged into the air by an ever-increasing number and complexity of sources.

AIR POLLUTANT SOURCES IN THE STEEL INDUSTRY

The major sources of air pollution in the steel industry may be divided into five groups:

1. coke ovens;
2. blast furnaces (including sinter plants);
3. steel-making furnaces;
4. boiler houses; and
5. miscellaneous sources.

STATUS TODAY AND FUTURE PROSPECTS

Coke Plants. The major air pollution problem created by coke-making plants is that of settlable particulates (coal and coke dust). The sources of coal dust and coke dust in a coke-making plant are many and varied. Since most of them are of the fugitive type, rather than captive, many of the important ones are difficult, if not impracticable, to prevent or control.

In addition to the coke- and coal-dust problems associated with coke-plant operations, sulfur dioxide, and, on occasion, hydrogen sulfide and other gaseous products from the destructive distillation of coal escape from the coke-making operations in sufficient quantity to evoke complaints from nearby residents who are located downwind from the plant.

Sulfur is an unwanted ingredient in steel processing and a highly undesirable element in steel products. Therefore, the steel industry is meticulous about the sulfur content of the raw materials entering the steel-making operations, including the fuel consumed in the steel refining processes. As a result, the coal used in coke-making is extraordinarily low in sulfur content, averaging very close to 1 percent. Consequently, even though the amount of coal consumed by the industry in making coke is very large, the amount of SO_2 created and emitted into the air is relatively low and has not been a serious problem in the past except in isolated and sporadic instances.

The escape of hydrogen sulfide and of gaseous products from the destructive distillation of coal in quantities of sufficient magnitude to create problems, or to evoke complaints from nearby residents, generally occurs only infrequently. Small amounts of such pollutants escape almost continuously from some of the many possible emission points at coke ovens. However, it usually is only the unexpected and abnormal event which permits the escape of a sufficient amount of such pollutants to create a temporary pollution problem.

Today, more than at any time in the past, the steel industry is engaged in a concerted program of top-flight operation and maintenance of its coke ovens in an effort to hold to the irreducible minimum the amount of smoke and gases escaping from the ovens. It is impossible with current coke-making equipment and procedures—that is to say, with current coke-making technology—to make coke without permitting some of the pollutants to escape.

Fortunately, with carefully operated and well-maintained ovens, the quantities escaping usually are so small as not to generate valid objections on the part of nearby residents. Coke-making is the major remaining operation in the steel-making industry where complete and satisfactory control of air pollution problem is sorely dependent on a breakthrough in technology.

While there is promise that the research currently in progress will bring about reductions of some of the sources, such as those associated with the charging operations, there is little hope of a complete solution to the coke-making problem short of a major change in technology.

Blast Furnaces. It has been standard practice in the steel industry for many years to clean to a high degree most of the heavily dust-laden blast furnace gases produced in steel making. Approximately 3.5 tons of blast furnace gas are generated for each ton of pig iron produced. Until recently, the amount of dust captured per ton of pig iron produced was in the neighborhood of 200 pounds. Consequently, the magnitude and cost of the equipment needed for blast furnace gas cleaning has been tremendous.

The improvements made 10 to 15 years ago in blast-furnace feed materials and in instrumentation have reduced almost to the vanishing point the number of malfunctions, known as "slips," occurring in blast furnaces. In addition, a change in the piping system and in the permissible top pressure has made it possible to contain most slips which actually do occur. The result is that it is very rare today for a slip of such magnitude to occur as to spring the escape valves high on the furnace and allow the heavily dust-laden gases to escape to the outside.

While the number of slips occurring in a large steel plant 15 years ago might have exceeded even 100 in a bad day, it is very rare today to experience any slips which are vented to the outside. What is more, the gas-cleaning facilities currently available at most blast furnaces employed in steel-making are such as to reduce the dust burden in the gases to a concentration of 0.01 grains per cubic foot or less.

Consequently, the tremendous dust problem which is inherent in the making of pig iron is under good control today.

Sintering Plants. Most large steel plants include a sintering plant. It provides a means of converting fine ore as well as many of the metallic waste products, such as blast-furnace dust, machine shop turnings, mill scale, and the like, to a porous clinker-type mass which is suitable for blast-furnace feed.

The sinter plant has several important sources of dust, the major ones being the windbox gases and the sinter-belt discharge. While most, if not all, sinter plants have collectors for removing the dust from the windbox gases, some of them are not of a type or of a capacity to permit cleaning the air to the levels required today. Many of the collectors were installed years ago and were in keeping with the standards then existing. Most sinter plant belt discharges were not provided with dust collectors until early in the past decade.

The sinter plant does not pose a problem which is incapable of solution. It seems reasonable, therefore, to expect that most sinter plants will be provided with adequate dust control equipment in the future as time, money and equipment become available.

STEEL-MAKING FURNACES

Between 80 and 90 percent of the steel produced in the industry was made in open-hearth furnaces until a few years ago. The other types of furnaces in common use today are electric furnaces and basic oxygen furnaces. The three types of steel-making furnaces will be discussed in turn.

Open-Hearth Furnaces. Prior to about 1955, all open-hearth steel was made in conventional furnaces. The process was a slow one, requiring 9 to 12 hours per heat. The development of the oxygen-lancing procedure about 1955 made it possible to so accelerate the steel refining process as to permit the making of a heat in about 6 hours. However, the use of oxygen-lancing increased tremendously the fume production with the result that a serious air pollution problem was created by furnaces which were oxygen-lanced.

The fume-production rate, which averaged around 12 pounds per ton of steel in uncontrolled open-hearth furnaces, was increased substantially in oxygen-lanced furnaces. Because of the tremendous variation from furnace to furnace and the dependence on the oxygen feed rate, a good average for the amount of fume per ton of steel produced by the oxygen-lancing process has not been reported. Presumably it ranges between 15 and 25 pounds per ton.

Owing to the great increase in fume production when using the oxygen-lancing process, most such furnaces were provided with adequate air pollution control equipment as rapidly as installation of the necessary equipment could be made. There are some exceptions, to be sure, but in the main, the open-hearth furnaces converted to oxygen-lancing are equipped with good control.

Because of the relatively low rate of fume produced by the conventional open-hearth process, and because of the uncertainty as to the need for pollution control on such furnaces, relatively few conventional open-hearth furnaces have been provided with pollution control equipment. Those factors, together with the replacement of conventional furnaces by other processes, make it unlikely that many conventional open-hearth furnaces will be provided with pollution control equipment in the future.

Basic Oxygen Furnaces. The basic oxygen process is a European development which was first used in the United States in 1955. During that year only about 300,000 tons out of a total steel production of 117 million tons was made by the basic oxygen process.

However, owing to its superiority over other methods of refining steel, the basic oxygen process has been adopted rapidly and by the end of this year will be accounting for production at an annual rate of about 38 million tons out of a total production rate for the year of about 134 million tons. In other words, in a period of 12 years, the basic oxygen furnace production rate in the United States has risen from zero to about 28 percent of the total steel production rate, and it will continue to rise rapidly in the future.

Because of the advantages of the basic oxygen process, the most important being the very short heat time of about 45 minutes, the conventional open hearth is being replaced rapidly by basic oxygen furnaces. Therefore, it is only a matter of time until all except a rather small proportion of the steel currently made in conventional, and uncontrolled, open-hearth furnaces, will be made in basic oxygen furnaces.

The advent of the basic oxygen process has been most fortunate for the steel industry. The age, space requirements, and nature of operation of the conventional open-hearth furnace are such as to make it impracticable in most instances to apply well-designed and effective air pollution control equipment.

Basic oxygen furnaces produce copious amounts of fume, which, while it varies tremendously from operation to operation, probably is around 25 pounds per ton. But since all such furnaces have been constructed during the past 10 or 11 years, the era during which air pollution control reached maturity, every furnace built in the United States has been provided with good air pollution control equipment as an integral part of construction.

There is little doubt that this procedure will be followed meticulously in the future, with the result that, as the conventional open-hearth production capacity is replaced by basic oxygen furnace capacity, the air pollution control problem which existed in the past and continues even today from steel-making operations will be resolved.

Since the steel-making furnaces as recently as a few years ago constituted by all odds the major air pollution source in the industry, the impact of the basic oxygen furnace on the air pollution control program in the industry is apparent.

Electric Furnaces. The third method of refining steel is the electric furnace. It is peculiarly well adapted to steel making in plants which do not have blast furnaces, and where hot metal is, therefore, not available. The time required to make a heat in the electric furnace is about 4 hours.

The amount of steel made in electric furnaces increased over the 25-year period from 1941 through 1965 from 2.9 to 13.8 million tons annually. In terms of percentage of total production rate, the increase was from 3.5 to 10.5 percent.

Because of an inherent characteristic of the construction and operation of steel-making electric furnaces, they create a unique air pollution control problem which is very difficult to solve. Such furnaces are charged by swinging the roof aside. Owing to the overhead equipment and structure required for the normal operation of the furnaces, it is impossible to design an effective hooding or capture system for the clouds of air pollutants which emerge from the furnace when a charge of cold scrap metal is dropped into it.

While it is quite common to provide a system of control by means of a direct or indirect roof takeoff which achieves effective dust and fume control during the melting and even during the tapping operation, a technologically acceptable method has not yet been found, to my knowledge, for capturing the pollutants and heavily-polluted air escaping during the charging operation.

In brief, air pollution control at electric furnaces can be achieved without difficulty for the refining and tapping periods, but not for the charging operations. It is my considered opinion that the charging problem will not be resolved to the satisfaction of all concerned until and unless electric furnaces or the materials charged into them are so altered as to permit doing so without the removal of the roof, as for example, through an enclosed screw-feed system.

It is eminently important that such a system be developed promptly, because as the older cold-charge open-hearth furnaces in isolated areas require complete rebuilding, the economics well may favor replacement by more versatile electric furnaces.

Boiler Houses. One other significant source of air pollution in integrated steel-making plants is the coal-fired boiler. Most such boilers operated by the steel industry today are provided with some degree of control. The control equipment in many instances is that which was considered at the time of installation to be adequate. Others have excellent control, and as time goes on, improved pollution control facilities are being added where required as time and funds permit.

Miscellaneous Sources. The storage piles of ore, limestone, and coal create problems in periods of high winds and dry weather which are difficult of solution. A satisfactory answer to the problem does not appear on the horizon at the moment. Since the particulate matter involved usually is large in size and much of it is heavy, it creates mainly a problem of dustfall for a relatively short distance downwind from the pile.

Therefore, the plants in which such piles are located more or less centrally may be fortunate enough to avoid all except an occasional and rare problem. By the same token, the plants which by dint of circumstances have the storage piles of raw materials close to property lines probably are creating air pollution problems in the areas immediately downwind therefrom.

This is a field in which great need for research exists. Effective and not prohibitively costly methods of treating such piles to prevent the dust from becoming airborne during high winds, especially in prolonged cold weather, are sorely needed.

SULFUR DIOXIDE

Relatively little was said earlier about sulfur dioxide. There are several reasons for this apparent oversight.

In the first place, since sulfur is an unwanted ingredient in the steel-making processes and an undesirable element in steel products, the steel industry is very meticulous as to the sulfur content of the coal used in making coke and in the fuel consumed in the steel-making furnaces. As a result a steel plant emits much less sulfur dioxide than would another industrial plant using the same amount of coal and oil.

Secondly, there is sharp divergence of opinions among the authorities in the air pollution field as to the importance of sulfur dioxide in the concentrations normally found in the ambient air, even in large cities where the day to day concentrations are relatively high, to say nothing about the many smaller communities where the sulfur dioxide levels are much lower. In other words, there is lack of agreement as to what the ambient air quality criteria or standards should be for sulfur dioxide.

Lastly, it is recognized by most responsible and knowledgeable people in the air pollution field that a practicable means is not available today for the removal of sulfur dioxide from stack gases. This situation is acknowledged and discussed in the report titled *The Adequacy of Technology for Pollution Abatement* prepared by the Subcommittee on Science, Research, and Development of the Committee on Science and Astronautics, U.S. House of Representatives, 89th Congress, and in a recent report issued by the U.S. Public Health Service titled *Technological Change as it Relates to Air Pollution*, under the heading "Major Unsolved Technical Problems."

FUTURE PROSPECTS

During the past year or two the steel industry has made it abundantly clear that an aggressive program of air pollution control will be carried out in its many and varied plants. The many statements which different steel company executives have made during the past year indicate that it is following a policy which comprises four major points:

1. All new plants and equipment which release sufficient air pollutants to be of concern will be provided during construction with pollution control facilities which are adequate to meet the pertinent laws and regulations, if such facilities are available.
2. The air pollution control facilities at existing plants and equipment will be improved as needed where feasible, or will be replaced with new and adequate air pollution control facilities where such are available, as rapidly as time, money, manpower, and equipment permit, so as to meet the existing laws and regulations.
3. With respect to those sources for which practicable solutions are not known, research and investigation will be carried forward aggressively with a view toward developing air pollution control equipment which is capable of meeting the pertinent laws and regulations.
4. The steel industry will cooperate with all levels of government in developing comprehensive pollution control programs and in intensifying the research activities in those areas where practicable solutions are not currently known.

The air pollution control activities of the steel industry in recent years give substance to the recent pronouncements by high-level steel industry executives with respect to the plans of the industry for air pollution control. Recent newspaper accounts are replete with references to the large amounts of money being spent or committed for air pollution control equipment in different areas of the country.

What is more, during the past 15 years, the steel industry has spent an estimated $250 million on air pollution control equipment, equipment which currently is costing the industry an estimated $30 million annually to operate.

Such equipment does not, of course, produce marketable products, and therefore income. It is for that reason that the industry continues to stress the importance of appropriate tax incentives to help ease the financial burden being incurred.

While it is impossible, of course, for the industry to make accurate estimates of the amount of money to be spent in the future for air pollution control equipment, it is likely that the annual rate of expenditure during the next 5 to 10 years will exceed that during the past 15 years. There is reason to believe that with the assistance being provided by technological improvements in prospect for all areas of the steel industry operations, the anticipated expenditure rate for air pollution control facilities during the next 10 to 15 years will have resulted in adequate control of all sources of particulate pollutants with the exception of relatively few minor and scattered sources.

And I might add that last Friday, at another meeting, a representative of HEW, I believe, stated that he had information which indicated that the steel industry expected to spend $600 million during the next 10-year period.

CONCLUSIONS

Rather than attempting to summarize in the usual manner what has been presented in this paper, I will close with a few cardinal points which deserve to be emphasized:

1. Air pollution control at blast furnace operations, in general, is excellent.
2. The most important single contributor of particulate air pollutants in the steel industry today, namely, the steel-making furnaces, is being brought under control rapidly and effectively as a result of the change in steel-making technology whereby uncontrolled conventional open-hearth furnaces are being replaced by basic oxygen furnaces equipped during construction with adequate air pollution control facilities.
3. The nature of the equipment and procedure currently employed in making coke for the steel industry does not permit complete control of the air pollutants created by such operations. A technological breakthrough is essential to the attainment of adequate and satisfactory air pollution control at coke-making operations.
4. Technological improvements are needed to permit effective and practicable control of the sporadic air pollution created when high winds blow across stockpiles of coal, ore, and stone.
5. The steel industry has made noteworthy progress in air pollution control in recent years and presently is engaged in a program of control which will make steel plants relatively free from major particulate air pollution problems by the end of the next decade.

". . . geologist . . . dust control engineer . . . consultant to railroads, insurance companies, and industrial corporations . . ."

CURRENT STATUS AND FUTURE PROSPECTS—CEMENT MILL AIR POLLUTION CONTROL

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INTRODUCTION

The Portland Cement manufacturing industry was born in the United States 100 years ago at a place on the Lehigh River called Coplay Station in Lehigh County, Pennsylvania. By 1900, the industry was shipping 10 million barrels a year and by 1957 the area accounted for 40 million barrels. The scope of this paper will be limited to the oldest and the most concentrated area of cement manufacture in the country.

At the present time, according to the U.S. Bureau of Mines, there are 180 cement-manufacturing plants in the United States. Figures for 1965 indicated the industry capacity within the continental United States at 468,963,000 barrels, while the actual production last year was 374,675,000 barrels of gray and white cement and 23,213,000 barrels of masonry cement or a total production of 397,888,800 barrels or 82.5 percent of capacity.

The region extends along a belt of limestone of Ordovician Age termed Jacksonburg Formation, which is about 25 miles long and scarcely a half-mile wide at some points, but it contains the right amount of calcium carbonate, silica, and alumina to produce a quality product for a large metropolitan market which includes the megalopolis from Bridgeport, Conn., to Washington, D.C. The emission of atmospheric dust in excessively high daily tonnages was as much a part of the industry as the brand names of the cement being manufactured. Residents in the area once considered the daily downpour of dirt as simply a necessary industrial byproduct which was a part of the employment, taxes, and other economic benefits which were offered to the municipalities as industrial manna. From the standpoint of industrial management, the loss to the atmosphere of 100 tons per day of partly-burned limestone, sand, and clay was of little importance to a cement plant, due to the fact that the raw materials were cheap and readily available. Anthracite and bituminous coal used to fire the kilns was highly efficient and a low-cost item.

The manufacture of cement is a dust-forming operation and the complete elimination of airborne dust is practically impossible. Dust is created at the blasthole drilling operation at the quarry, during blasting at the rock face, during loading of the haulage trucks by power shovels and front-end loaders, at the primary and secondary crushing plants, in the ball and rod mills, at blending and transfer points on the raw and finish sides, and in the final bag-filling and bulk truck- and railroad car-loading operations. However, it must be stated that in order to control all of these points of emission it is necessary for some plants to install as many as 60 high-efficiency dust collectors throughout the operation. These dust collectors handle low-temperature gases which do not present any particular problem other than that of constant maintenance and repair.

The most serious problem from a technological standpoint involves the dust separation from the hot kiln gases. This problem is as old as the industry, but there are modern developments which now point to the end of this long-standing source of nuisance and property damage.

All kilns in the region are of the horizontal rotary type, varying from 125 feet in length for old kilns to 550 feet for new kilns and, with the exception of one, all are suspension-fired, using powdered bituminous coal or a combination of bituminous and anthracite. A very important factor in connection with pollution control is the fact that no two cement plants are quite alike. Kiln lengths and diameters vary greatly. Some plants blend the powdered raw materials in dry homogenizing silos while others use water homogenizing and still others blend mechanically. A wet-feed plant may have a raw-materials slurry containing as much as 33-percent moisture. Three of the area plants still use the hot gases discharged from the kilns to fire waste-heat boilers for steam turbines which operate electric power-generating stations. Due to the present trend in decreased power rates as supplied by public utilities, the waste-heat powerplants are rapidly going out of service and being dismantled.

All of the foregoing factors result in great variations in gas volumes, temperatures, moisture content, gas quality, and velocities, which alter dust loading of the gases considerably. A general statement concerning dust in suspension for a wet-process-kiln exit gas would be about 5 grains per cubic foot, for a dry process about 7 grains, and for a vertical-type preheater-equipped kiln about 15 grains. The exit-gas temperatures will vary from about 300 degrees F. to slightly above 1500 degrees and the fuel-efficiency ratios from 600,000 BTU's to 1,500,000 BTU's per barrel of cement produced, a barrel representing 4 cubic feet or 376 pounds.

LEHIGH VALLEY PORTLAND CEMENT REGION

Chemical analysis of raw kiln feed dust

Wet plant A, coal fired	SiO_2	Al_2O_3	Fe_2O_3	$CaCO_3$
Type 1 cement...	12.92	4.34	1.70	75.69
Type 2 cement...	14.36	3.20	3.00	75.05
Type 3 cement...	12.92	3.61	1.55	77.09

Chemical analysis of kiln dust from precipitator outlet

[In percent]

Wet plant B, coal fired	Sample No. 1	Sample No. 2	Sample No. 3
CaO.............	41.0	39.2	42.6
SiO_2.............	19.60	19.8	17.0
Al_2O_3.............	6.10	7.10	8.14
Fe_2O_3............	8.72	11.4	8.81
MgO.............	2.56	2.16	2.62
Na_2O............	1.16	1.10	.89
K_2O.............	7.40	7.93	6.70
MnO.............	.16	.16	.15
TiO_2.............	.12	.12	.13
CuO.............	Trace	Trace	Trace
Ignition loss......	13.25	12.10	12.75

NOTE.—No determination of sulfur was made.

The wide range of physical conditions makes it quite difficult, from an engineering standpoint, to design adequate dust-separating facilities, since each installation must be tailored to suit individual plant conditions. It would be reasonable to state that the combination of circumstances described makes it very expensive in time and money to reduce the dust-emission rate from a cement plant to a point where there are no justifiable reasons for complaint from residents in the adjacent municipalities. Coupled with time and cost is the fact that the recovered dust has very little value, since most of it must be handled as waste. However, some plants are learning to use a portion of this captured material in certain types of cement.

In order to assess the extent of nuisance and property damage which existed in the region ten years ago, reports to the governing bodies were made by nationally-known air pollution experts employed to conduct surveys in the region's municipalities. In one report it was stated that a number of tests indicated that more than 4,000 tons of dust per square mile fell in every part of the community in a year's time. Another report stated that as high as 1,200 tons per square mile per month fell at check points in a residential area near a cement-manufacturing plant.

As a result of lawsuits and general area dissatisfaction, local air pollution control ordinances were enacted and an administrative agency set up during the latter part of 1957. From that time forward, there has been a downward trend in dust emissions and in nuisance and property damage, although at times, progress seems agonizingly slow.

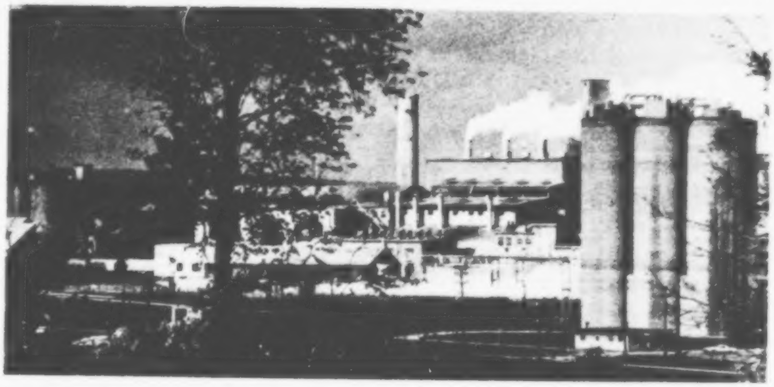

FIGURE 1. Well-maintained fiberglas baghouses about 6 years old which continue to operate with a minimum of maintenance and repair. This plant is located inside the limits of a municipality and, due to the installation of adequate high-efficiency filters, the company enjoys excellent relations with the public. This plant might well be able to operate within city limits if the need arose.

DUST-SEPARATING EQUIPMENT

Some 2.5 million-barrel-a-year plants may operate as many as 60 dust collectors, which will cost as little as a few thousand dollars for small ambient air cleaners that handle displaced air when bulk tank trucks or railroad cement cars are being loaded. When cement is transported by air pumps to and from silos it is necessary to clean the displaced air with larger fabric filter units. However, the hot kiln gases, which contain pulverized raw and partly-burned calcareous and agrillaceous particles in high tonnages, present a major problem due to the fact that the gas volumes are generally greater than a quarter of a million cubic feet per minute; contain acid gases such as hydrogen sulfide and sulfur dioxide, with varying amounts of water; and have a temperature range usually above 500 or 600 degrees F.

LEHIGH VALLEY PORTLAND CEMENT REGION [5]

Particle size weight distribution (an approximation), raw kiln feed

Microns:	Percent
60 plus	18.6
55 to 60	4.4
50 to 55	3.9
45 to 50	5.0
40 to 45	4.3
35 to 40	4.8
30 to 35	5.7
25 to 30	5.5
20 to 25	6.3
15 to 20	8.5
10 to 15	9.5
5 to 10	12.7
0 to 5	10.8
Total	100.0

The combination of conditions requires primary scalping of larger particles, above ten microns, by the use of multiple-cyclone mechanical dust-separating equipment ahead of the fiberglas baghouse filters or ahead of an electrostatic-precipitation unit. It has been demonstrated in the industry that a draught fan will not last many months when it is placed on the dirty-gas side or ahead of the multiclone collectors, since abrasion causes very rapid wearing away of fan vanes and scrolls.

Moisture in the gases presents a dew-point problem which can only be solved by the application of very heavy insulation on all ducting, fan casing, drop-out hoppers, breechings, and dust-collector walls. At the present state of the art, kiln-gas fiberglas filters are limited to about 500 degrees F. gas temperatures and electrostatic precipitators are pretty well limited to not much above 600 or 650 degrees, due to the fact that the steel in the fans starts to oxidize at around 600 degrees. Stainless steel will withstand much higher temperatures without damage, but the added cost has prevented wide acceptance in cement plants.

Baghouses and precipitators have cost a million dollars in individual cement plants in the area.

LEHIGH VALLEY PORTLAND CEMENT REGION

Particle size analyses of cement kiln dust (before entering dust collector)

[In percent]

	Sample No. 1	Sample No. 2
Microns:		
+45	3. 1	1. 8
−45+40	. 7	1. 0
−40+35	1. 4	1. 5
−35+30	2. 0	2. 2
−30+25	3. 4	3. 5
−25+20	5. 4	4. 8
−20+15	10. 0	7. 9
−15+10	22. 5	16. 3
−10+5	38. 5	43. 0
−5	13. 0	18. 0
Total	100. 0	100. 0

NOTE.—Most area cement manufacturing plants grind the raw kiln feed to a range of 80 percent to 90 percent through 200-mesh screen or minus 75 microns. Any chains, lifters, or heat exchangers inside the kiln will materially increase the amount of dust in suspension in the exit gases. The vertical-type preheater is composed of 4 refractory-lined stages or cyclones which are mounted in a vertical structure sometimes 200 feet high. The hot gases from the kiln are pulled upward through the stages while the raw dry-kiln feed is dropped from the top of the preheater, counter to the gas flow. In a matter of 20 seconds or more the raw-dust temperature rises from 120°–140° F. to 1400°–1500° F. which results in remarkable fuel economy. However, the amount of dust suspended in the exit gases rises considerably above that which is suspended in a rotary kiln without the vertical preheater of this type.

Every phase of cement conveying or transport involves the movement of high tonnages of finely-divided materials of which any release to the atmosphere immediately creates an air pollution problem. To detail all of the dust classifying and separating equipment which uses ambient air or low-temperature air would be wholly unnecessary since the types are well known and all would fall within the classification of very-high-efficiency filters.

Much of the low-temperature dust-separating equipment is operated intermittently, cleaning volumes of air which would seem insignificant when compared with the high-volume gas emissions of the rotary kiln with its dust in suspension, which is measured in tons per day.

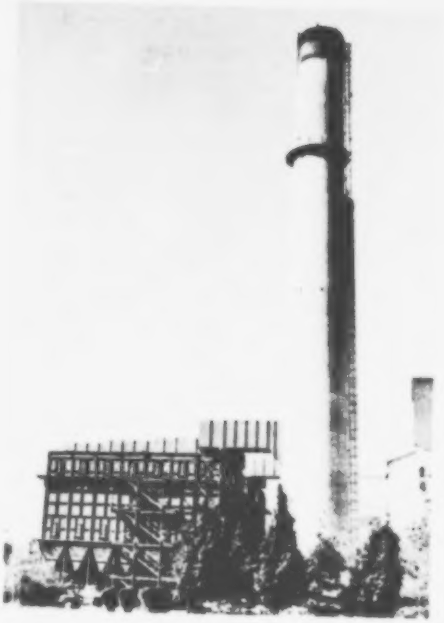

FIGURE 2. Rotary kiln equipped with modern Fuller-Humboldt preheater system showing ingenious arrangement of 8 concrete silos which contain 480 fiberglas bags approximately 39 ft. long x 1 ft. diameter. The baghouse cells are top entry manifolded from mechanical cyclones, cleaning about 120,000 cubic feet of gas per minute.

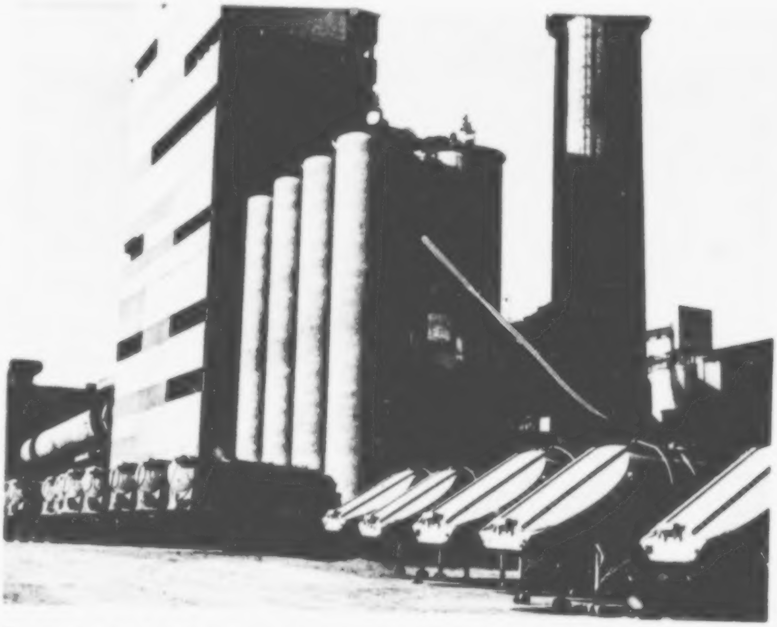

FIGURE 3. Lehigh Valley Portland Cement plant in foreground is equipped with four fiberglas baghouse filters for four modern kilns. Cement plant at right rear of photo shows discharge from three kilns, equipped with electrofilters, through main stack. Two fiberglas filters are also in use which discharge at points not connected with the main stack.

Electrostatic precipitators were installed in some regional plants as early as 1927, when efficiencies of 80- or 85-percent dust retention appeared to be quite high. Depending on the location of the plant and local meteorology, it is now quite apparent that 95-percent dust retention can be extremely bothersome under adverse atmospheric conditions. Since the weather cannot be controlled, the heavy burden of 99-percent efficiency is now recognized by all residents in the area as being reasonable and desirable. The only limitations which enter the problem at present are those which are economic.

Due to the nature of cement plant operation, where it is necessary to operate kilns on a continuous basis, every day of the year, around the clock, the operation of electrostatic-precipitation equipment has not been entirely satisfactory, not only from a maintenance and repair standpoint, but also from the standpoint of shortcomings inherent in design for this type of equipment. A common expression used by cement-plant management is that you can spend a million dollars on electrostatic-precipitation equipment and not do the job you intended to do.[2]

A properly designed precipitator, when new, may start out with a very high efficiency rating. However, in a year or two, several changes begin to take place. Energizing and collecting electrodes assume a heavy coating of sulfides and sulfates originating in the kiln fuel, which are deposited as fume. Alkalies of mineralogical origin in the limestone contribute toward forming a dense shell or coating on high-voltage components, reducing the ionization characteristics and therefore the dust-separating efficiency. Arcing and burning of filaments in some of the older precipitators frequently cause short circuits which require the de-energizing of a section for repairs. No precipitator in the region has extra sections for such an emergency and the uncleaned gases are bypassed to the atmosphere until repairs are made. Sometimes these repair periods last from four to eight hours and housewives with clothes drying on the line are very quick to complain of property damage when clothes need rewashing.

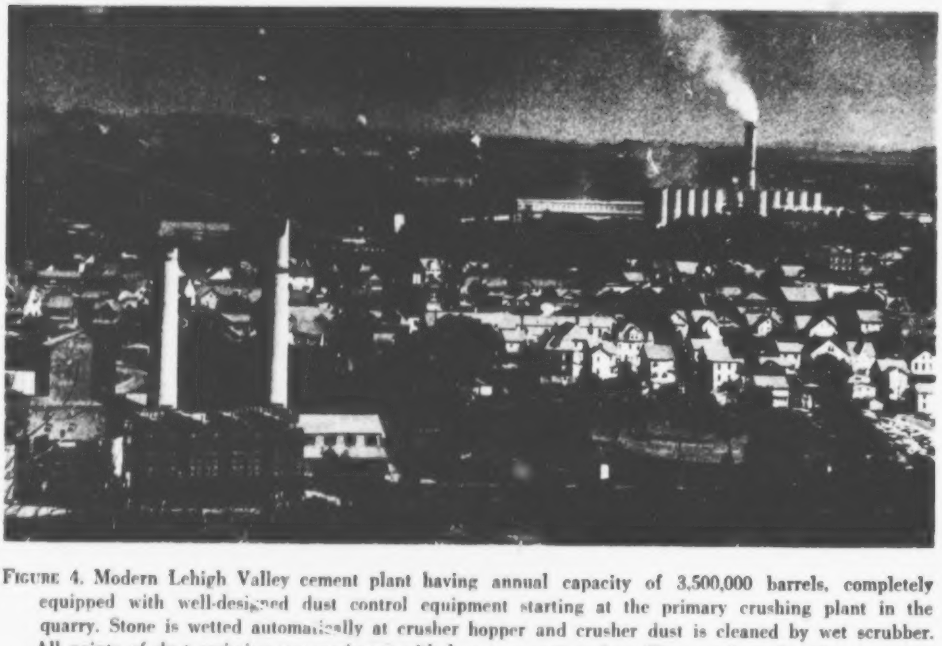

FIGURE 4. Modern Lehigh Valley cement plant having annual capacity of 3,500,000 barrels, completely equipped with well-designed dust control equipment starting at the primary crushing plant in the quarry. Stone is wetted automatically at crusher hopper and crusher dust is cleaned by wet scrubber. All points of dust emission are equipped with low temperature bag filters and stack kiln gases are cleaned by baghouse equipped with 1968 fiberglas bags. About 55 dust collecting units are in service ranging from a few thousand c.f.m. up to 300,000 c.f.m.

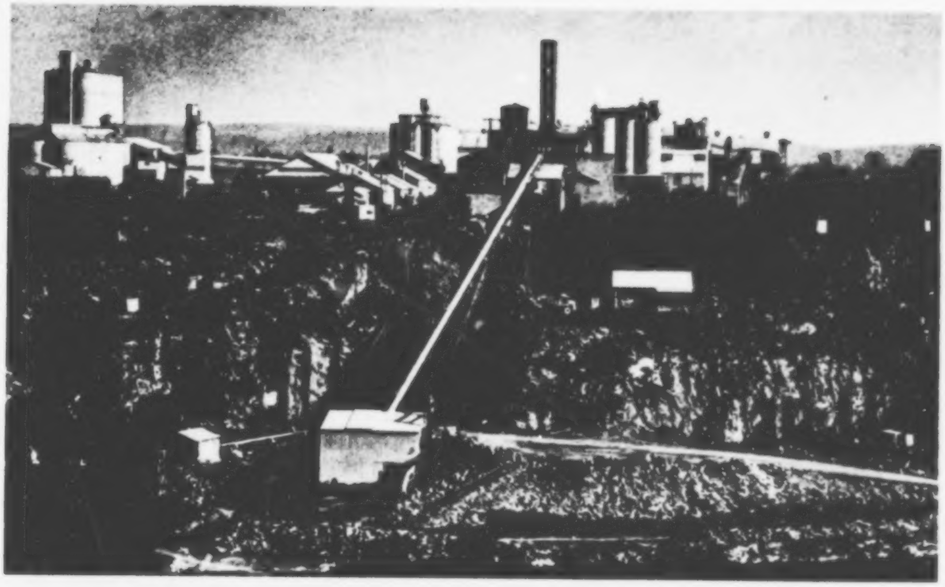

FIGURE 5. 65-year-old cement plant which operates eight short kilns which are followed by waste heat boilers. The gases are partly cleaned by six mechanical multiclones of 24-inch diameter which discharge through three sheet metal stacks. Plant modernization program includes installation of kiln preheater system, dispensing with waste heat boiler plant and installation of fiberglas baghouse on all kilns to be completed by the end of 1967.

It seems incongruous to state that 98-percent or 99-percent efficiency can be attained by an electrostatic precipitator when such efficiencies cannot be maintained. In Europe, it is claimed that electrostatic filters were of remarkably constant efficiency (more than 99-percent even after a long period of service) and gave complete satisfaction.[3]

It would seem that the attainment of smooth and uninterrupted dust collection with an electrostatic precipitator in a Lehigh Valley cement plant would require that all such units should be followed by another precipitator having equal capacity or be followed by a fiberglas baghouse filter. Only in this way can the quality of air cleaning be maintained on the continuous basis which is necessary and desirable due to the insidious nature of cement-plant kiln stack dust.

THE FIBERGLAS-BAGHOUSE FILTER

In the Lehigh Valley area, the fiberglas-baghouse filter has been very satisfactory from the standpoint of reduction of nuisance and property damage. Good tubular-glass filterbag maintenance has resulted in practically 100 percent control efficiency. Bag life averages two years or more, and control mechanisms have not shown any appreciable wear or high maintenance costs, bearing in mind that most units of this type are less than seven years old. Tensioning of filterbags to perhaps 50 to 100 lb. permits better cleaning, which in turn requires fewer reverse air cycles. This practice has resulted in longer bag life. A big plus in baghouse installation is the fact that duct designs are quite simple and uncomplicated, requiring little study for the flow of gases when compared with the frequently complicated model studies necessary for good gas-flow patterns in the electrostatic-type dust collector.[4]

The simplicity of design and operation of the fiberglas-bag filter system, which lowers the cost, is balanced to some extent by the increased fan-power needed to offset the drop in pressure across the baghouse. Many baghouses operate with a 3- to 7-inch drop in water gauge as a result of forcing the gases through ducting, valve mechanisms, and bag fabrics. Fan installations will vary from 250 to 600 H.P. and up to

25 inches static pressure. Gas temperatures must be limited to about 550 degrees F. maximum although moisture content may vary greatly without inhibiting the operation of the filter. In wet-type plants kiln feeds may average 22-percent moisture. Wet filterbags continue to operate without trouble unless the baghouse is shut down. Then the concretions which form may do real damage to the glass fabric after startup.

The original cost of a baghouse is generally lower than that of the electrostatic precipitator, where very high efficiencies are required by law. This lower cost may be offset over the years by the higher power cost of operating fans which must run around the clock, with a greater pressure needed to overcome the filter resistance. However, the results attained by a fiberglas filter, when properly maintained, are 100 percent and without neighborhood complaints of any kind, even when the plant is located in the middle of a municipality. This type of good public relations is quite different from that experienced with the electrostatic precipitator, which is the subject of frequent complaint and turmoil in the surrounding neighborhood.

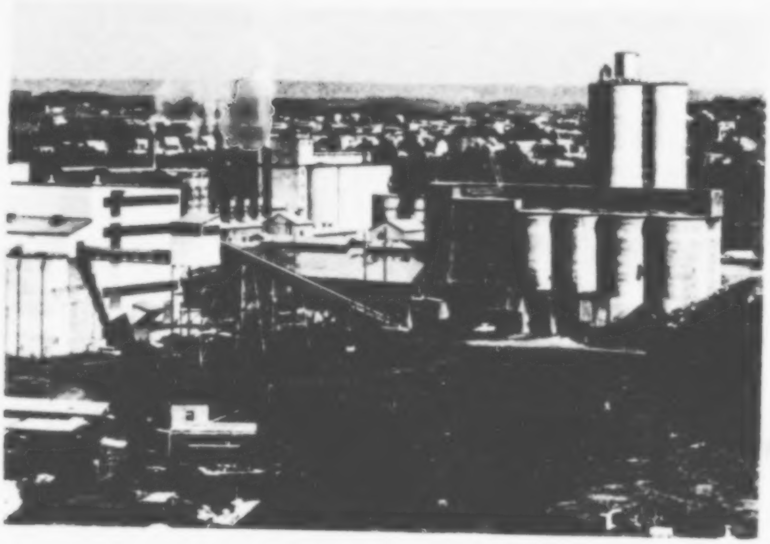

FIGURE 6. This Lehigh Valley Portland cement plant which was built in 1903, has been modernized with a new raw mill, new packhouse, new blending silos and new bulk loading silos. The last major step remaining is the installation of two new kilns which will produce about 2 million barrels per year. Complete engineering details include new clinker-coolers and a large fiberglas baghouse filter installation for cleaning kiln gases with an efficiency greater than 99 percent.

When a glass bag breaks in an upward-flow baghouse, it can be tied off near the inlet thimble with a length of fiberglas rope in a few seconds and the bag compartment put back in service immediately until such time as a new bag may be installed without bypassing uncleaned gases to the atmosphere, as would be the case when an electrode short-circuits in a precipitator.

Many times kilns in the region have been shut down for repairs or due to market conditions and have cooled to ambient temperature. When cold kilns are started up again, it is necessary to bypass the electrostatic precipitator for periods up to 24 hours due to the danger of explosion caused by the presence of combustible gas or coal dust. The arcing and sparking inside the precipitator provide a constant source of ignition which is not present in the fiberglas baghouse. One precipitator explosion in the Lehigh Valley region resulted in damage in the amount of $48,000 during the first few hours of kiln startup.

DEWPOINT

The methods used in avoiding dewpoint temperatures in glass-bag collectors generally require the use of adequate insulating blankets on dropout hoppers, ducting, fan casings, and compartment separators, especially in severe winter weather, when ambient temperatures sag below zero F. When it is necessary to shut a kiln down for repairs for a few days in cold weather, the F.D. fan and the fiberglas baghouse are kept operating in order to avoid the rapid condensation which could create considerable trouble when starting up a cold kiln. If air is simply kept moving through the fabric, the bags do not get wet. Water alone would be bad enough, but condensed moisture in contact with cement dust could be the source of very expensive troubles.

EFFICIENCIES

Frequently we hear of new electrostatic precipitators with efficiencies of 98 percent stated by the manufacturers, which seems quite high. Looking into the situation further we find that some of our large cement plants may discharge 100 to 150 tons of gas-borne dust to the outdoor air every 24 hours. A precipitator having a dust-separating efficiency of 98 percent would reduce this dust load to only 3 tons per day. Experience would indicate that downtime for repairs, coupled with a normal decline in efficiency, would soon result in 10 tons or more per day, which would not be acceptable in most modern communities.

If tandem dust-separating units are used, such as mechanical cyclones preceding the electrostatic, the condition would be somewhat better. In this case mechanical multiclones could be expected to scalp off about 70 percent by weight or all of the coarser particle-size fractions, or a reduction from 150 tons to 45 tons. If the precipitator followed the multiclones, the weight of the particulate matter going to the outside air would then be 0.9 tons under the best conditions and, after a few years, possibly 3 to 5 tons, which might be acceptable.

In the Lehigh Valley Portland Cement region, where 12 plants operate continuously, 8 plants have installed fiberglas baghouses on some kilns or on all kilns. Due to the fact that 5 municipalities have enacted stiff air pollution control laws which affect 10 plants, more than 8,000 fiberglas bags are presently in use and more are being installed almost monthly. The Pennsylvania air pollution law will ultimately force the remaining two plants to install highly efficient dust-separating systems also. The trend in the Lehigh Valley Portland Cement region, which produces about 7 percent of all the cement in the United States, is away from the electrostatic precipitator and toward the siliconized fiberglas-baghouse filter system. The once-neglected portion of environmental sanitation, air pollution, is now dictating many changes in old-plant modernization programs aimed at cleaner air in the Portland-cement-producing region.

The big plus in glassbag-filterhouse design is the extra capacity which permits one or two cells to be shut down during the reverse-air cleaning cycle or to permit repairs, without any overall loss of dust-separating efficiency. This type of operation, which permits repairs without bypassing uncleaned kiln gases to the atmosphere, is most desirable where cement plants are adjacent to municipalities. The people of the area are tired of nuisance and property damage resulting from excessive cement dustfall. They expect the Portland-cement-manufacturing industry to clean up completely. At the present time the job is around the 75-percent point. The remaining 25 percent involves some very serious economic considerations which are not easily solved. One thing is certain. Modern thinking in the Lehigh Valley area is that the cement industry should clean up or close up.

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". . . corporate manager of environmental health, Hooker Chemical Corporation . . . engineer . . . industrial member of N.Y. State Pollution Control Board since inception . . ."

CURRENT STATUS AND FUTURE PROSPECTS—CHEMICAL PLANT AIR POLLUTION CONTROL

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New York City

As a background for my remarks on the chemical industry, I'd like to cite a brief case history which spans a period of about 30 years. It is one which illustrates a change in attitude which I believe to be representative of by far the majority of the companies that make up the chemical industry—and, as a matter of fact, of industry in general.

In the late 1930's, one major chemical manufacturer built a new headquarters building and included in the artistic decorations a quotation from Johann Joachim Becker, dated 1669, which reads, "The chymists are a strange class of mortals—impelled by an almost insane impulse to seek their pleasure among smoke and vapor—soot and flame—poisons and poverty—yet among all these evils I seem to live so sweetly that may I die if I would change places with the Persian King." The manufacturer gave this a place of prominence by inscribing it over the front door, and there it remains to this day.

In today's complex society I am certain that the company concerned would not want to perpetuate this image. Quite the contrary, in fact; I know that that company and many others in the industry wholeheartedly subscribe to the policy position adopted by the Board of Directors of the Manufacturing Chemists' Association more than two years ago. I quote from a part of that policy statement:

"The chemical industry's responsibilities in enviromental health matters derive from the nature and use of its products, from its research and production activities, and from its role as a segment of the economy and society. Effective action requires a high level of individual and corporate responsibility and continuing effort to plan and carry out production operations so that they conserve health and safety of all those employed in the production of chemicals and conserve environmental resources, particularly by controlling and limiting emission and disposal of industrial wastes.

"Further, the industry's objectives are to assure the fitness and appropriateness in the use of the industry's products by research and study aimed at broader and deeper scientific knowledge of the handling, application, and ultimate fate of chemical products, and the education of those who sell, handle, and use chemical products by clear instruction in all aspects of handling, use, and disposal, recognizing the need for change with the accumulation of further knowledge."

Before I proceed with some specifics, I would like to enter one disclaimer for the industry, which is well pointed up in the recently issued and excellent report of the Daddario Subcommittee of the House of Representatives which dealt with the adquacy of science and technology in dealing with the pollution problem.

In this report it was stated that "this industry [chemical] is sometimes unfairly accused as the principal source of pollution. This is because the major effect of environmental contaminants is through chemical reaction. But life itself is a chemical process, and the contaminants arise from all industry and from all homes and autos."

In keeping with the scope of our organization, my comments will be devoted solely to the chemical manufacturing industry. Actually, the industry has been in the forefront of the campaign to control and eliminate the problem of air pollution in the communities in which it operates. Long before air pollution became a national issue, the chemical industry was actively engaged in providing for the health and safety of its employees and the community. Obviously, the very nature of the products of the industry, some of them highly toxic, has required the closest attention to a safe working environment as an integral part of any production process.

Our very favorable record of performance in industrial hygiene certainly is ample testament to our performance. Over 15 years ago, to spur awareness of the need for unified action, the MCA, a trade association representing more than 90 percent of American chemical manufacturing capacity, established a committee on air pollution control. Since that time, through the efforts of MCA and the individual companies, the industry has continuously made large-scale investments in men, minds, and money to find effective, efficient ways to control and eliminate air pollution.

Towards that end, the industry has sponsored research and information programs. The Air Quality Committee of the MCA, has promoted the application of effective techniques for pollution abatement and control with considerable success. MCA regularly furnishes information and policy guidelines to its member companies. Earlier this year, the Board of Directors issued a policy statement on the critical subject of threshold limit values. To quote from the Conclusions of that report:

"MCA urges that member companies give serious consideration to establishing or expanding in-plant surveillance of environmental contamination by chemicals, and that this be combined with an appropriate medical program to define the impact of the environment on the workmen. The data derived from such studies should at appropriate times be considered for scientific publication or submission to the Committee on Threshold Limits of the American Conference of Governmental Industrial Hygienists."

In keeping with this policy of surveillance of the effect of chemicals on environmental health, MCA in cooperation with other industries is supporting research on emphysema. The industry's interest relates to a general concern with the causes and effects of air pollution, although it is significant what Dr. Abel Wolman of Johns Hopkins University told the House Subcommittee on Science Research and Development hearings this year:

"Air pollution is suspect as an etiological factor in the production of chronic bronchitis, but it is difficult to indict it with certainty since it is but one of many noxious factors in urban life. The same guarded conclusion may be made with respect to emphysema. It is still less than clear that polluted air has any significant impact upon this disease."

Yet whether or not air pollution is a factor in emphysema and other respiratory disorders, the chemical industry wants the answers, especially to those vital questions relating to the health of our communities and our citizens. The U.S. chemical manufacturing industry is high among the leaders in investment of money for waste treatment facilities.

This is not to say that the industry is self-satisfied or to imply that it means to rest on its laurels in the battle against air pollution. But it is to say that the chemical industry was an early volunteer in the war on air pollution, and its commitment to this battle is a total one.

Of course, it would be an overstatement to claim that every chemical manufacturer is free of community offense at every location. Admittedly, there are underarchievers with respect to air pollution control. But it is a matter of record that the overwhelming majority of the Nation's manufacturing chemical companies recognize their responsibility to the community and to the Nation in this vital area of public concern.

Moreover, it is well to point out that what the chemical industry has done and is doing in meeting its responsibility in the fight against air pollution has been primarily accomplished through voluntary action, before and since the passage of air pollution laws and ordinances. Four years ago an MCA survey showed that 125 companies, operating almost 900 plants in 500 American communities, invested 212 million in air pollution control equipment alone, with operational costs of $24 million annually. These same companies plan to spend an additional $49 million in air pollution control hardware in the next 5 years.

They were spending $2.8 million annually on air pollution research and employing the equivalent of 1,340 full-time people in air pollution control.

We are currently starting on a review of these figures to update them, and I think we will find a significant increase in these numbers.

Of course, the most desirable avenue of approach to solving the air pollution problem lies in the modification of processes to avoid or minimize emissions of airborne contaminants. The chemical industry uses these procedures wherever feasible. This was mentioned earlier, and I think it is well to note that this is a very difficult thing to assess in total, as to time and money spent, since it does tie in so closely with process operation. It should be noted, however, that of over 8,000 chemical process operations reported in the recent survey, one-third were free of discharge of any emissions to the atmosphere under normal operating conditions. Further, nearly half of the total had installed controls to reduce or curb emissions.

To the surrounding communities, however, many chemical plants are best known for their fragrance, and the industry recognizes the need to develop effective odor-control programs as an aid to improved community life. Toward this end, MCA is undertaking research on the odor threshold of various compounds.

An increasing concern to many of our major communities today is photochemical smog and, recognizing the need for additional information and data regarding the behavior of chemicals in the atmosphere, trichlorethylene producers are planning research on this compound.

Up to this point, I have spoken of industry and inter-industry efforts. With the intensification of government interest in air pollution problems, however, the industry has made clear its determination to cooperate with all levels of government in the interest of more expeditious progress. At the Federal level, MCA has a continuing joint activity with the U.S. Public Health Service, in assembling and publishing information on atmospheric emissions from selected chemical manufacturing processes. The first report on sulfuric acid manufacturing processes was released last year. The second in this series, concerning emissions from nitric acid processes, is now in print and will be publicly available shortly. Several more are in various stages of development.

Regular meetings of our Air Quality Committee are arranged in various States in order to include visits with air pollution control agency personnel, who are also invited to participate in our workshop programs. However, much has been done in the past, it is certain that the future will demand more, if we are to control and preserve the quality of our atmosphere at an acceptable level. Health must not be sacrificed, whatever the cost.

But let us be equally zealous in guarding against needless overprotection in order to avoid wasting our resources. In this connection, the Daddario Committee report previously cited has done much to put into the proper perspective the matter of cost vs. benefits, and has pointed out that, ". . . although there is ample opportunity to apply available technology, targets are frequently illuminated and popularized which could wait until more knowledge is obtained."

To deviate from my prepared text for a moment at this point, I noticed yesterday that several speakers spoke in a derogatory way of statements which recommended that items which can be delayed until further data are collected be delayed, implying that we ought to do something immediately about everything. This is a point on which we can easily be led astray. There are too many things that could be worked on, and I think it's very important that we select those that are most critical and most significant and focus our attention on these for quick correction. Other items, which are not of major importance, can be weighed in the balance and handled, as time permits, in the way that is most economical.

With respect to other aspects of air pollution, I am sure that the chemical industry will strive to insure that its social conscience is clear and that its rate of progress in performance will be at the vanguard in industry. We are confident that the chemical industry has the determination and the technological capability to solve the air pollution problems incident to our own operation, and that it will be alert to opportunities for contributing to progress in other fields of air pollution control as well.

". . . combustion engineer . . . past president, Air Pollution Control Association . . . member of faculty, University of Michigan and Wayne State University. . . . air pollution control officer of Detroit. . . ."

CURRENT STATUS AND FUTURE PROSPECTS—FOUNDRY AIR POLLUTION CONTROL

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SUMMARY

The foundry industry within the past few years has demonstrated a healthy growth due to technological developments and significant market penetrations on the use of ductile (nodular) iron into formerly untapped fields of application. The collector manufacturers have just about reached a point of being able to supply reliable and economically acceptable high-efficiency control systems for the large operators, having been able to overcome most of the problems formerly associated with collector performance under sustained operating conditions.

Many small-foundry operators, however, will still find it difficult if not impossible to absorb required collector costs unless a breakthrough in collector technology or cupola-process design changes effect needed cost reductions in equipment for this class of operator. Government- and/or joint government-industry-sponsored research on collector design and rapid tax write-offs and exemptions would be most helpful in developing and encouraging the installation of required equipment.

If regulatory agencies assume their basic responsibility and exert firm but reasonable effort to require compliance with recognized achievable standards, the problems associated with foundry operations, including the cupola, can be eradicated nationally with five years. We now have the control equipment available; industry now has the financial resources. All that remains is for government to catalyze these two facts into the reality of action for the benefit of mankind.

INTRODUCTION

When I was invited to participate in this Conference, I was informed that the audience would be principally nontechnical people and that the general purpose of the meeting was to provide some insight on the assigned topic without undue technical references. This paper should, therefore, be considered a general summation of the "state of the art" in the foundry industry today, with an attempt to predict the extent of future government regulation of this industry and the response the industry will make to this regulation.

In an effort to focus attention on the main problem associated with the foundry industry, I will make no special reference to the emissions associated with sand-handling and mixing systems; shakeout devices; grinding, chipping, cleaning, or welding operations; and similar related activities.

All of these operations are easily and readily controlled by the use of a wide variety of dust-suppression equipment. The foundry industry generally accepts the need for controlling such operations and can justify the investment required therefor.

The central discussion will concern the grey-iron cupola, which is the most difficult and generally the most costly process activity requiring control in an integrated foundry facility. Except for the Los Angeles area, most governmental units in the country have gingerly approached the problem, recognizing the difficult and relatively costly nature of effectuating a solution. Because of this, the grey-iron-foundry cupola is probably the least controlled stationary major pollution source in the country today.

FOUNDRY INDUSTRY—EXTENT AND GENERAL HEALTH

The metal casting industry is the fifth largest manufacturing activity in the United States, accounting for over $9 billion worth of products annually. It is estimated that there are over 6,000 foundries in the United States today, with over 3,300 cupolas in use among them. Within the last four years the industry has experienced a rate of growth far in excess of the gross national product (GNP), thereby establishing it as a true growth industry.

In general, the foundry industry within the past five years has overcome the "sickness" of the late 1950's and, through technological advances in equipment design, metallurgical quality control, and new market penetrations, has evolved basically into a very healthy industry.

GREY-IRON CUPOLA—NATURE AND EXTENT OF EMISSIONS

The grey-iron cupola still melts over 93 percent of all the grey iron produced in the United States. The challenge of electric-arc or induction furnaces has not yet deeply penetrated melting requirements, although it is to be expected that competition from these techniques will heighten over the next few years.

This should especially develop as government agencies require the costly adoption of control systems on cupola operations. The use of such elaborate or costly control devices is not required with the usual induction melting techniques. Therefore, the price advantage now enjoyed by the cupola will gradually diminish as control systems are added or contemplated.

The grey-iron cupola in its simplest form is a vertical pipe, either lined with firebrick or backed by a water curtain for temperature control. On the average, cupolas range in diameter from 18 to 108 inches. Cupola melting rates range from 1 to over 50 tons per hour for the large continuous-production-type units. The latter units are commonly used in automotive and equipment-manufacturing foundry operations.

The typical cupola is alternately charged with scrap iron, scrap steel, coke, and limestone; by skip hoist, bucket elevators, or other conveniently-weighed charge method. Molten iron is periodically tapped into ladles or holding furnaces for later use in the making of castings.

The quality of scrap, to a great degree, affects the emission of dust and fumes to the atmosphere, as an oily charge can generate huge volumes of black smoke, and fine chips can significantly increase metal-fuming rates.

Because of the wide divergence of ratios of charge materials utilized, and the varying quality of the scrap, no simple accurate estimate can be made on the nature and quantity of pollutants emitted from foundry cupolas. Each furnace must be carefully evaluated and tested before meaningful engineering solutions to the emission problems can be effected. Various tests indicate total particulate emissions from 10 to 45 lb. per ton of melt.

Of principal concern to air pollution control agencies is the particulate emission, which accounts for from 2 to 12 percent of the total particulate emission to the atmosphere in many urban areas. The smaller jobbing-shop-type units present more of a neighborhood nuisance problem whereas the larger units (20 tons/hour or more) have community-wide detrimental effects.

Due to the variety in chemical nature of the particulates and to highly variable operating conditions, it can be expected that

TABLE I

Code severity	Code limitations		Approximate collector efficiency required, percent
	Lbs. part. 1,000 lbs. gas	Grains part./SCF gas	
Weak code	0.85 and over	0.47 and over	60
Moderate	0.40 to 0.80	0.20 to 0.40	60–80
Stringent	0 to 0.10	0 to 0.05	95+

the particle-size range will be wide. Typical particle-size distributions are as follows:

Particle-size range, microns:	*Percent by weight of total particulate*
0 to 5	4–10
5 to 10	2–15
10 to 25	4–15
25 to 50	5–15
50 and over	45–85

The last size (50 μ and over) is easily removed from the gas stream by simple control devices but fine particles (less than 10 μ) call for difficult and costly applications of control equipment.

PRESENT-DAY CONTROL CODE REQUIREMENTS

A review of the hundreds of regulatory measures governing air pollution control discloses that only a few agencies have developed specific standards of expected performance from grey-iron cupolas. Many agencies have standards which apply generally to all sources of pollution but are usually exceptionally lenient and ineffective in eliminating problems associated with the operation of cupolas.

Table I lists degrees of code severity associated with estimated cupola and collector performance requirements. Table II lists levels currently specified in several major urban areas.

PRESENT-DAY FOUNDRY CUPOLA CONTROL CAPABILITIES

Although no accurate appraisal is available at present, it is probable that over 50 percent of the cupolas in operation today are not equipped with any type of control

TABLE II[1]

	Allowable particulate emission					
	Lbs. part./1,000 lbs. gas		Grains part./SCF gas		Lbs. part./hr.	
Cupola melting rate, tons/hour	20	40	20	40	20	40
Government jurisdiction:						
Chicago, Ill.[2]	*0.70*	*0.70*	0.35	0.35	*150*	*300*
Cleveland, Ohio[2]	.50	.50	*.25*	*.25*	*107*	*214*
Detroit, Mich	.10	.10	*.05*	*.05*	*21*	*42*
Los Angeles, Calif.[2]	*.15*	*.18*	*.08*	*.09*	33.1	40.0
Milwaukee, Wis.[1]	[3].85	[3].85	*.43*	*.43*		
New York City, N.Y.[2]	*.14*	*.20*	*.07*	*.11*	30.9	48.8
Philadelphia, Pa.[2]	[4].85	[4].85	*.43*	*.43*		
Pittsburgh, Pa	.50	.50	.25	*.25*	*107*	*214*
San Francisco, Calif.[2]	*.16*	*.20*	*.08*	*.10*	34.4	44.2

[1] Numbers are actual code requirements. Numbers in italic are converted calculated values.

[2] Code also specifies equivalent opacity limitations, which practically in cupola applications makes this standard more restrictive than most of the objective standards noted. Los Angeles tests suggest a maximum exit loading of 0.06 to 0.08 pound per 1,000 pound.

[3] 12 percent CO_2.

[4] 50 percent E.A.

device except perhaps for a vent cap and/or chains and screens to impede spark carry-over. The first, and now considered rudimentary, approach to control dust and fumes was to install a simple water-spray system utilizing a wetted cone baffle or similar configuration. These devices are probably used on 25 to 45 percent of the cupolas in use, and are now considered unacceptable by the more aggressive control agencies and do not even permit attainment of particulate control within the "Moderate Code Limitation" category noted in Table I.

The earliest attempt to effect high-efficiency dust and fume control were undertaken in Los Angeles by the use of electrostatic precipitators and baghouses. Although published reports on these attempts indicated general success, the life and dependability of these systems left much to be desired. Electrostatic precipitators failed to maintain high collection efficiencies because of the wide variation of particulate-gas-stream conditions, i.e., temperature, humidity, volume, and particulate chemical composition. Several later attempts to use electrostatic precipitators in other sections of the country similarly met with operating difficulties and within the last several years no new known attempts have been undertaken.

The baghouses used in Los Angeles also experienced operating problems, especially due to factors such as poorly controlled inlet-gas temperatures, resulting in either bag burnout due to high temperatures, or "blinding," due to condensation of water vapor at low temperatures. Another difficult gas-stream contaminant to contend with was smoke, which was either not filtered out of the gas stream or, if filtered by a fine-mesh bag, was the cause of fires on bag surfaces or in storage hoppers. Proper design and use of afterburners, water-spray gas-conditioning systems, and increased cloth/gas ratios, have greatly minimized operating problems. Bag life and general maintenance of baghouse systems still require relatively high continued operating costs. One foundry operator in Detroit is currently spending close to $100,000 per year in maintenance and operating expenses on a baghouse fitted to a 40 ton/hour cupola.

Within the last several years, venturi scrubbers have been installed successfully in an attempt to do away with the problems generally associated with electrostatic and baghouse designs. Some of the earlier installations, although acceptable from a maintenance viewpoint, were not acceptable as to collection efficiency, due to the use of relatively low-pressure drop systems (in the water-gauge range of 20″ to 40″). Recent designs have required pressure drops in the water-gauge range of 60″ or more to attain control within the strictest code requirements. At this pressure drop, fan-horse-power requirements of over 1,000 are not uncommon, and the resultant electric operating costs are quite high. Sufficient long-term operating experience is quite limited on high-pressure drop systems, and thus it is too early to predict the final outcome of this approach, although it appears quite promising.

It should be clearly noted that these latter high-efficiency and high-energy collection systems are being or have been installed only on the large cupolas (20 tons or more, except in Los Angeles). The smaller units and those operated in jobbing shops, which may melt only two or three times a week for three or four hours a day, find such systems technically attractive but beyond their financial capabilities. These operators are experimenting with mid-efficiency scrubbers or cyclone collectors which yield collection efficiencies between the achieved by the simple wet-cap or wet-baffle system and the costly high-efficiency designs.

Table III lists estimated installed collector costs for the cupolas noted.

OTHER FOUNDRY PROBLEMS WORTHY OF NOTE

Although the focus of attention of this paper has been on the foundry cupola, other problems associated with foundry operations deserve recognition. Recent technological advances in core making and certain molding operations (shell moulding and the patented Full Mold styrene molds) cause the generation of odorous and sometimes acrid fumes which can cause local nuisance conditions. Effective, practical, and financially acceptable control systems have not been developed to solve this problem.

The increasing use of ductile (or nodular) iron has added one additional source of fuming to the already difficult problem of cupola emission. This is caused by the intermittent evolution of magnesium, chromium, nickel, or molybdenum fumes during alloy additions in the receiving ladle. Practical solutions to this problem have not yet been achieved.

Table III

Approximate cupola size	Melting rate, tons/hour	Estimated installed cost	
		Mid efficiency	High efficiency
		Thousands	*Thousands*
72 inches inside diameter	16	$80-$100	$300-$200
108 inches inside diameter	50	$250	$1,000

FUTURE NEEDS AND PROSPECTS OF FOUNDRY CUPOLA CONTROL

With the ever-increasing public clamor for cleaner air, it should be expected that local code requirements will be tightened to require the control of cupolas within the stringent code requirements previously discussed. Technology has now placed the installation of such equipment within the grasp of the larger cupola operators (20 tons/hour or more). In general, firms operating units of this size can accept the high financial burdens attendant upon such systems designs, even though installed collector costs can exceed one million dollars per cupola. *The real impediment to having such units installed on existing or new facilities will be the failure of government to insist that it be done.*

The smaller-foundry operators are not confronted with a technical problem here, but with a financial one. It would appear that these firms will eventually be either forced out of business or required to merge with other firms in order to acquire the necessary capital to build satisfactory control systems. It has been suggested by one local foundry-plant engineer that several jobbing-shop operators could form cooperative business ventures by sharing the cost of building an acceptably controlled new cupola facility with a hot-melting capacity to fulfill total demand requirements. This will result in a common price for hot metal to each participating foundry operator. From here, each company would remain "independent" by competing and producing his special products in the normal fashion in its local satellite shops.

The use of electric induction or arc furnaces will be attractive to certain operators, especially those casting small parts, and the operation of cupolas in these cases will be discontinued. Present research on an externally coal-, gas-, or oil-fired hot-gas generator utilizing pure oxygen may ease collector costs by a theoretical 80 percent reduction in gas-flow treatment volumes and, therefore, a potentially large-scale reduction in collector size and cost. This research effort is being sponsored in part by most of the jobbing-shop cupola operators in Detroit as a demonstration of good faith in seeking a means to meet ordinance requirements by an economically acceptable method of control.

Some small-scale operators may be able to effectuate melting cost advantages by the addition of an electric-induction holding furnace. This could permit reduction of cupola operation to alternate days and a saving in cost by elimination of "pigging." In effect, emissions would be basically halved because of alternate-day cupola operations.

It would also appear desirable to consider adaptation to existing cupolas new charging or gas takeoff methods which could offer significant and worthwhile reductions in discharge-gas volumes. A closed-top cupola with double-bell-type charging mechanism, as used in blast-furnace operations or below-charge gas takeoff systems, may be helpful in effecting sufficient reductions in gas-flow volumes to bring collector requirements within financial reach.

In general, quoted collector costs appear excessively high in relation to prices quoted for equivalent capacities on other dust-control applications. Perhaps the difficulty of the problem and the tendency for "over-engineering", the limited market potential as compared to other fields, and the overall high risks involved, have caused the apparently severe inflated pricing of high-efficiency cupola, collectors and hence the great difficulty in encouraging or requiring their use. What is sorely needed is a breakthrough in collector design so that overall efficiency will not be as sensitive to rapid changes in gas-flow rates, temperature, humidity, and/or chemical and physical qualities of the particulate to be removed. Efforts should also be directed to achieve equivalent overall collector efficiencies at markedly reduced total-power requirements. The market potential for such equipment appears exceptionally attractive, probably requiring the total investment of $100 to $300 million to adequately control all the existing cupolas in the Nation which will be retained in operation.

CONCLUSION

The air pollution problems confronting the foundry industry generally are amenable to control by application of existing technology. Future emphasis will have to be placed on simplification of cupola-collector designs with markedly reduced maintenance and operating expenses, especially for systems required by the smaller-foundry operators. The use of electric induction and arc furnaces will receive increasing interest and use, especially by the small-foundry operator as an answer to the question of whether to install nonproductive collector devices or utilize new melting techniques.

The odor and fume problems associated with core making and the newer molding processes must receive additional attention, as practical and economical abatement systems are not presently available to solve these problems.

Not only must government assume its basic responsibility to *enact and enforce* legislation to control foundry emissions to protect the health, comfort, and welfare of the public, but it must also share in the responsibility of developing with the industrial community new approaches, methods, and/or equipment to reduce air pollution. Such incentives as rapid tax writeoff and tax exemptions on air pollution control facilities are worthwhile government contributions in the joint government-industry partnership goal of achieving cleaner and more tolerable air for our citizens.

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CURRENT STATUS AND FUTURE PROSPECTS—REFINERY AIR POLLUTION CONTROL

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I am sure that I speak not only for petroleum, but also for all other industries represented here this week, when I say that we heartily endorse the spirit that motivated the calling of this conference, namely, that all segments of our society—business, labor civic groups, and the various levels of government—can profit by coming together to take stock of our progress and discuss future steps toward our common goal of a better environment.

Certainly, no one can deny that more discussion and action are needed. For, as Secretary Gardner has pointed out, "the problem still grows at a faster rate than our combined Federal, State, and local efforts to cope with it."

Although the first Federal Act dealing with Air Pollution was passed a little more than ten years ago, in 1955 to be exact, much of the technology for controlling air pollution is still in its infancy. I refer to controlling pollutants such as oxides of nitrogen, and desulfurization of flue gases. And progress in the application of existing technology could certainly stand further stimulation.

But part of our purpose here today is to examine how far we have come. I think you will find that we in the petroleum industry have not been standing still.

The oil industry has been engaged in air conservation research and practice for almost two decades, both through the efforts of individual companies and through programs of its trade association, the American Petroleum Institute.

It is dangerous to generalize about air pollution control practices at petroleum refineries because of the diversity of refinery processing operations. One reason for this diversity is the many kinds of products that any given refinery may manufacture—from gasoline to petrochemicals to jet fuels to diesel oil to asphalt. And the list is growing every year.

Refinery air conservation practices vary widely, depending on the type of operations carried on. Other important variables are the prevailing weather patterns and the location of the plant with respect to population centers. Both weather and plant location have a significant bearing on how much control is needed.

In fact, much of the emerging need for investment in both air and water pollution control facilities has come about as a result of forces beyond the control of our refineries. For example, a plant originally built in comparative isolation may find itself enveloped by expanding suburbs and new industry. Suddenly, a problem may develop where none existed before. And the plant may be faced with the necessity of updating old equipment, or completely replacing older units.

Of course, every refinery has a number of potential sources of atmospheric emissions. These emissions can be either visible or invisible, and they can be either odorous or odorless. Potential sources may include stacks; bulk storage tanks; loading facilities; pipe fittings; valve and pump glands; and sewers. The emissions most important to us are smoke, hydrocarbons, various sulfur compounds, particulate matter, and carbon monoxide.

Let me briefly discuss what we're doing about some of these emissions. Nowadays, smoke is rarely produced by refineries in any objectionable amounts, and need not be produced at all. For one thing, furnaces and burners have been vastly improved in recent years, and gas and liquid fuels have largely replaced solid fuels.

Waste-gas flares, which are used to dispose of gases collected from small leaks, were once a source of considerable amounts of smoke. Now, however, they are mostly of the smokeless type. To achieve this, air or steam is injected into the flare to promote better combustion. And the old practice of "burning off" waste ponds has given way to smokeless incineration or waste recovery and reprocessing. Many refineries do, of course, give off white plumes of condensed steam. Harmless as such plumes are, they can be a source of public misunderstanding.

Hydrocarbon emissions have received much attention in some areas. This is because certain hydrocarbons can react chemically in the presence of sunlight and nitrogen oxides to form substances characteristic of the Los Angeles type of smog.

The smog-forming potential of refinery and bulk storage hydrocarbon losses is very small. This is because the so-called "reactive" hydrocarbons form only a small percentage of the total losses, which are themselves very small.

Refineries have made large investments to control hydrocarbon losses—especially evaporation from bulk-gasoline storage facilities, where the floating-roof tank is rapidly replacing the older cone-roof tank. The spreading practice of inline blending of gasolines also reduces refinery hydrocarbon emissions. At loading facilities, subsurface loading arms are often used to reduce losses.

Oxides of sulfur are also of great concern to us, because they have been directly implicated in air pollution episodes. The petroleum industry has managed, through improvements in technology, to reduce the sulfur content of its main products—gasoline, furnace oils, and diesel fuels—by more than 50 percent since World War II.

On the other hand, the production of cleaner-burning fuels has increased our responsibilities with regard to disposal of sulfur compounds.

The sulfur content of crude oil varies greatly. This sulfur may be in the form of hydrogen sulfide, free sulfur, or organic sulfur compounds. During the refining process, most of this sulfur is converted to hyrogen sulfide, which must be disposed of.

Refineries have found that some of the cost of disposal can be covered by converting the gas to elemental sulfur, or the sulfur can be converted to sulfuric acid, which can be used or sold. In fact, sulfur-recovery efficiencies as high as 99 percent have been reported. Because the volume is usually not large enough to produce low unit costs, sulfur rarely can be justified by economic considerations alone. Nevertheless, refineries are spending nearly $8 million this year alone to recover sulfur. This, of course, also reduces sulfur oxide emissions.

To remove particulate matter from stack gases, primarily in the catalytic cracking process regenerator flue gases, refineries use various types of gas-cleaning equipment. These include scrubbers, cyclone separators, and electrostatic precipitators.

Although carbon monoxide emissions from refineries are not large, we have been finding ways to reduce the discharge of this gas from our stacks by using it as fuel in waste-heat boilers.

Finally, fume and odor control is a new major item in the oil industry's air pollution control budget. During 1966, more is being spent for this than ever before, and the control of fumes and odors is becoming a more and more important part of our cost of doing business. We are discovering that it is an important aspect of being a good neighbor to smell clean too!

What about the future? Although it is often dangerous to generalize, a number of recent developments would indicate that the outlook in refinery air pollution control is very bright indeed.

First, there is a growing awareness, on the part of oil company management, of the emerging need to tighten emission controls. One evidence of this awareness is the appointment, all within the past year or so, of air and water conservation coordinators by 19 of the major oil companies.

But the most significant developments have been in the rapidly advancing technology of petroleum refining itself. More often than not, reduced emissions are an automatic byproduct of new processing schemes.

These new processes are being adopted at a rapid pace, and capital construction at U.S. refineries is at an all-time high. This, however, is not resulting in a large net gain in crude processing capacity. The reason is that we have been abandoning outmoded units almost as rapidly as new ones are built. Furthermore, because of the increasing number of shutdowns of marginal plants, it is quite likely that by 1970 there will be fewer refineries on stream that there are today. But they will be much larger and much more efficient.

As new units are built, air pollution controls are automatically included. These controls are an integral part of the efficient design required for competitive operation today. Furthermore, expansions and modernizations of existing units almost always include provisions for air pollution control.

There are, of course, many specific examples of how improvements in refining technology are reducing refinery emissions. I will cite just a few.

Our process widely used in refining today is fluid catalytic cracking. In this process, greater operating efficiency can be achieved by using regenerator flue gases to drive expansion turbines which in turn drive blowers and generators, and further may provide carbon monoxide as fuel for waste-heat boilers. But the gases must be relatively free from particulate matter before such energy recovery is possible. To clean the gases of particulate matter, mechanical cyclones and electrostatic precipitators are used. This is another example of how air pollution control is a byproduct of modern refinery technology.

Such energy-recovery systems are now in use in many areas of our country. Undoubtedly we shall see this process used more and more.

Another comparatively new development, called "hydrocracking," is the fastest-growing new process in refining today. It is significant from an air pollution standpoint because it recovers sulfur in a form that can then be converted to elemental sulfur or sulfuric acid.

The use of this process is predicted to double its 1965 level by the end of 1967. Its growing popularity is partly responsible for the significant decline in domestic production of so-called residual fuel oil. The reason is that the process makes it possible to convert more of the barrel of crude oil into higher-value distillates and gasoline.

Another process, called "alkylation," is also experiencing record growth. This also bodes well for air pollution control, because alkylation is essentially a closed-system process and results in no significant emissions. The use of this process increases the volume and quality of gasoline produced without a corresponding increase in pollution.

Undoubtedly, further oil industry research and development in refinery technology will bring about even more efficient methods for control of emissions. That has been the pattern of the past, and it will be the pattern of the future.

I'd like to stress one further point. As one who has spent most of his life in the refining end of the oil business, I can tell you that there have been great changes in attitudes toward plant housekeeping. Oil refiners today recognize that a tight plant—and by that I mean a plant that is designed and well maintained to minimize leaks and losses of all kinds—is an efficient plant.

So today, many features designed to control such leaks are being built into refineries and included in modernizations. These include vapor-reduction equipment at loading facilities, positive mechanical seals on pumps, and venting of pump glands and pressure-relief valves to vapor-recovery systems or waste-gas flares. These are just a few of the features being built into refineries today.

Of course, even with these controls, adequate employee morale and pride in good housekeeping are essential to a tight operation. Good maintenance and cleanliness may never appear in an air pollution control budget, but they may well be responsible for as much progress in this field as any single technological development.

Thus far I've been speaking about the efforts of individual oil companies. But the oil industry as a whole is also making and will continue to make another important contribution to the fight against air pollution—through research.

The American Petroleum Institute this year greatly expanded its program in air and water conservation. It budgeted some $2 million in 1966 for 29 separate air conservation research projects sponsored at various universities, independent laboratories, engineering firms, and government laboratories. Its 1967 budget, approved last month, exceeds $2 million.

This research program is a two-pronged effort. On the one hand, it is aimed at developing some of the technical and economic information needed to better understand the causes and effects of air pollution and how it might best be controlled. On the other hand, we are seeking some of the medical and biological data we now lack on the effects of pollution on man and his environment.

Our technical research is currently concentrating on two main areas, first, sulfur oxide pollution from the burning of so-called residual fuel oil and, second, automotive emissions.

In addition to its studies of technical problems, API is sponsoring and cooperating in a number of projects designed to determine the long-term, low-dosage effects of specific pollutants and combinations of pollutants.

Since this is largely a new program, there are no results to report as yet, but the results will be disseminated when available. None of our research is proprietary or confidential. Thus, we are making a substantial contribution to the basic knowledge so sorely needed if we are to have reasonable air pollution control regulations.

I'd like to stress this point. The oil industry believes that scientific knowledge is the only sound and socially responsible basis for legislation and regulation. For this reason, we endorse intensive governmental, industrial, and university research into the complex nature of the causes of pollution—and the still largely unknown health effects of various combinations and various levels of pollutants.

From time to time, we hear or read that someone has predicted that society is heading for disaster—that we shall either suffocate in a poisoned atmosphere of our own making, or that we shall be buried in our own rubbish. At the other extreme are those who refuse to acknowledge air pollution problems.

The petroleum industry is unwilling to accept either of these extremes. It believes that the responsibility for taking action to conserve or improve the quality of our nation's resources, depending on the situation, is shared by individual citizens, business and industry, and local, State, and Federal governments—and that the best solution will be achieved through the cooperative efforts of all these people.

In the final analysis, all of our citizens will be paying the bill for whatever control steps may be taken. They are entitled to a reasonable cost-to-benefit consideration.

Speaking for the petroleum industry, I assure you that we will live up to our responsibilities.

QUESTIONS AND COMMENTS

OWEN ASPLUND (*Associate Professor of Chemistry, University of Wyoming*): A new and rather disturbing source of dust pollution is a transportable gravel-crushing and -aggregating plant associated with roadbuilding. Is there proper technology available for bag filtering suitable for this type of operation? And about what percent of the total investment would be represented by these devices?

DOHERTY: The mobile roadbuilding plant can be adequately equipped to meet anybody's standard. But when the contract is let, this should be taken into consideration, because the price would differ in companies that had adequate control equipment from those which did not.

However, I'm inclined to believe this is not a great factor in many municipalities. People who install sewers or build streets or highways are usually realistic and, while they'll complain for a few months, they know it's something that's coming to an end. I don't know what the cost is, but I know that many companies have spent a great deal of money on controls for mobile roadbuilding equipment.

STOCKTON: Would the fact that these plants are operating in the construction of interstate highways affect municipal jurisdiction over them?

DOHERTY: A municipality under common law exercises very wide police powers to protect itself against any eventuality. This would therefore come within its control.

STOCKTON: My impression is that some work is being done, but that it is not finished and the information is just not available at this time.

Our next question is addressed to Mr. Doherty: "How effective are the siliconized fiberglass bag filters for the collection of fine particulates on the order of ½ to 1 micron in size?"

DOHERTY: A properly installed, properly designed, and properly maintained fiberglass bag filter system, whether siliconized or treated with graphite or any other metallic coating, eliminates all reasons for complaint, and if you have three or five kilns which are ducted to one stack or one discharge point, there is nothing visible being emitted to the atmosphere; unless you had some interest in the plant, you wouldn't know it was operating.

A number of tests have been performed, and actually, there is no reason for testing. The problem has been eliminated. In the efficiency range with which I am familiar, 99.65 percent was the lowest and 99.95 the highest. This is a pretty fair range and I'd say there wouldn't be too much particulate matter of 1 or ½ micron going to the atmosphere.

STOCKTON: The next question is not particularly addressed to the topic we have discussed this afternoon, but I would like to ask either Mr. Brandt or Mr. Wilkenfeld to try it on for size.

GEORGE E. BEST (*Chemical Engineer, Manufacturing Chemists Association, Washington, D.C.*): Comments at yesterday's plenary session might be taken as recommending uniform, nationally applicable air quality standards, federally enforceable, with justification, at least in part, for the elimination of competitive aspects of differing requirements. What are the views of the industrial panel on such a possibility, which would seem to be a departure from national policy as now enunciated in the Clean Air Act?

GAMMELGARD: I'd like to speak to that for a moment. I can't see any reason for making national air quality standards for an industry for a competitive reason. The reasoning is unsound, in my opinion. No other factor entering into the manufacturing cost a plant incurs is made nationwide. Fuel varies all over this country from the Gulf Coast to the Northeast. Labor costs are different. Probably the biggest variable of all is transportation of raw materials into the plant and transportation out to the market from the plant.

To say that this one factor in the total picture should be made equal, when what you are trying to do, in my opinion, is to set reasonable air quality levels for the community involved in breathing that particular air, just doesn't make any sense to me. I think it would be economically very costly to the Nation as a whole.

WILKENFELD: I agree with Mr. Gammelgard; I think it should be noted that some of the costs that he mentioned are ones that are subject to government regulation now, such as freight rates, wage rates, and so on. And these are not uniform.

Further than that, the need for uniform national standards is, I think, a myth. I think no one will disagree that there are two things that you have to consider in air pollution. First is the effect on health, and nobody questions the need for avoiding this as an absolute minimum. Health protection is being taken care of, I hope, through the ambient air criteria which the Public Health Service is currently developing under the Clean Air Act; they will provide the background and bases for setting ambient air standards.

Second is the question of a local community's customs, desires, and willingness to pay. I'm sure that people in different parts of the country have different interests and want different things. Some want the magnificent views and the ability to see for 50 or 60 miles. Others are more interested in maintaining a highly competitive economy and many other things. So I think it's important that the local community be given an opportunity to weigh and measure what its people desire.

We have followed this approach in New York State, with success, I think, and with very fine acceptance by the population. But in none of the classifications we have proposed for ambient air do we consider any levels which might cause health hazards.

BRANDT: About all I can say to that is "amen." As we came into the meeting today, Mr. Doherty and I were talking about this very point, and we agreed that there was no justification whatsoever for uniform emission rates for air pollutants, nor is there any valid argument for requiring the same limitation for an entire industry because of the competitive situation as between different plants of that industry.

In the State of Pennsylvania, incidentally, the permitted levels and the emission rates vary depending on the nature of the area, the type of industry, the stack height, and a number of other things. Everything is taken into consideration, and that is as it should be. As we see it, there is absolutely no justification for using the argument that we've got to have regulation for regulation's sake, just so that we can be sure that every plant is competitive with every other one. They never have been in the past; they will not be in the future.

STERLING: If I may make some comments from the governmental viewpoint—it seems to me that the Federal Government is already charged with the responsibility under the Clean Air Act to set ambient air criteria, from which individual communities at their own option can set ambient air quality standards. Once these standards are in effect, then it would seem to me that it's the task for the local agencies to develop specific emission standards for that particular region, in order to achieve the air quality goals they set for themselves.

BRANDT: I don't believe there is any justification whatsoever for uniform national air quality standards, except for those pollutants and in those concentrations which constitute health hazards. In other words, for nuisance pollutants the limits should be permitted to vary from locality to locality, from State to State. Where, however, it has been demonstrated that health is involved, that's different. Then you must have uniform national standards, obviously.

EDWARD F. WILSON *(Bureau of Air Pollution Control, Pittsburgh)*: What specific way can air pollution control agencies or industrial management act to improve plant level operations of both existing and new collectors of air-cleaning devices to obtain the best possible performance continually, from these non-value-producing items, in order to come as close as possible to the theoretical limit of emission control?

STERLING: I'm not sure I can answer it adequately, but, as I understood the question, it is tied into the existing facilities; once they're placed into service, what kind of relationship should be established between government and industry to see that this sustained high efficiency is maintained?

The primary responsibility obviously is with the industry that put this equipment in. In many instances, government has enacted laws which provide for the recurring inspection of these facilities, on a permit basis or through some other mechanism. It is on this basis perhaps that government has a proper entree from a legal viewpoint, to see that this equipment is maintained in a state of good repair and high operating efficiency.

But further than that, it would seem to me that a relationship of a more informal nature might be established between the service groups of these firms and government staffs working together and stressing the need for constant vigilance and constant attention. This kind of emphasis perhaps could be undertaken more energetically by government at this time.

C. HIBBARD SAVERY *(Mechanical Engineer, John Deere & Co., Moline, Illinois)*: Discuss the oil company organizational structure as to pollution coordinators. In other words, whom do they work for?

GAMMELGARD: The individual air and water conservation coordinators report, as I understand it, to quite a few different operating vice presidents, and in a few cases to a staff vice president for engineering or for research and development, but more often for manufacturing or refining. This will probably evolve, since it's relatively new and untried, into a pretty uniform pattern after a few years.

QUESTION: Is it customary to describe capital investment in diesel locomotives as an air pollution control investment?

STOCKTON: My answer is that I was trying to stress that the solution is sometimes a process change. This was a case in point where, through such a change, a particular smoke problem was resolved. I don't know whether it is proper to take credit for this as air pollution control, but, as far as the general public is concerned, I'm certain that they appreciate the fact that this change was made to help reduce the total amount of smoke being discharged.

JOHN STEPHENS (*Senior Industrial Hygienist, General Motors, Detroit*): If I may supplement Mr. Sterling's statements, I would state that self-washing, single-stage turbo-compressors have been serving quietly and reliably as exhaust fans on some cupola gas-cleaning systems.

HUGUET: In Mr. Wilkenfeld's paper, he indicated that the chemical industry has in development some new processes which would reduce air pollution. I wonder if he could give us an example of one of those.

WILKENFELD: Yes. You realize that one of the problems in discussing pollution control in the chemical industry is that there's a fantastic diversity of processes, as well as products. There are all kinds of examples that can be found, but one case that is near and dear to my mind is a process which we operate at one of our plants at Hooker.

There was a terrible nuisance problem at this plant because the residue material produced in the course of manufacture was highly reactive, and emitted tremendous quantities of fumes when handled for disposal. It was just noxious from the word "go." It was irritating; it was colored; everything you could find wrong with any product this thing had. And we had no good way of reducing the amount of residue produced, and no good way of disposing of it. We had built several disposal facilities, none of which worked.

So we spent many thousands of dollars on this. We finally went back to the laboratory and said, "We want to change the process. Design a new process, if you can, that will not produce a residue".

After considerable work, over several years, we did come up with a completely new process via a different route, for making the product, and we had to build a totally new plant. But fortunately, in addition to eliminating the residue, it made the product cheaper.

This we never included in any estimate of money spent on air pollution control, because it was a new process to make a product which made a profit and almost coincidentally solved the pollution problem, though actually the original research started as a search for a method of avoiding a pollution problem. This is the best kind of solution because there is no pollution problem any more. We're not reducing by some fixed percentage, but 100 percent.

I wish we had thousands more cases like this to cite. I know that there are many more, but they're hard to pick up because people in the chemical industry don't like to get involved in discussing specific products and the costs of operating processes.

". . . former newspaperman in New England and in St. Louis . . . veteran of Korean conflict . . ."

CONCLUDING REMARKS

ELIOT F. PORTER, Jr.
Executive Secretary,
Missouri Air
Conservation Commission
Jefferson City, Missouri

I think we can all be encouraged by the attitude which these papers we have heard today reflect. I recently took a look at the Proceedings of the 1962 National Conference on Air Pollution, and in the panel that corresponded roughly to this one Victor Sussman, air pollution control officer for the Commonwealth of Pennsylvania, read an amusing paper, a "critique," in which he gave a little formula for the probability that air pollution devices would be installed on any given industrial operation. What it said, essentially, was that the probability was a function of the last quarterly dividend. I think that what we've seen at the present conference indicates that there has been some change.

No one today, I noticed, suggested that the cost of air pollution control would be ruinous to the economy or that it threatens the very foundations of the free-enterprise system.

The phrase "economic reasonableness"—a sort of semantic booby-trap which still adorns some of the more quaint statutory language in this field—seems happily to be disappearing. Its meaning was never very clear to me nor, I suggest, to most of us.

The papers indicate that American industry, at its best, is nearing adulthood in its approach to the air pollution problem.

The question now seems to be not *whether* to control, but *how.*

The emphasis that you heard repeated today was on maintenance, and on the maintenance of control equipment, which I found very impressive because this, as any control officer knows, is a great problem. The emphasis was also on process change, not just new contraptions, but process change, and this is encouraging. It reflects the fact that the panelists here appreciate the continuity of the problem, and that control is not something you can deal with once and be done with.

I'd like to suggest, however, that what we have listened to here is not so much the typical reaction of people in industry as that of the cream of the crop. Those of us who have to deal with the problem out in the provinces still encounter the kind of outlook on air pollution which I'm afraid would be something of an embarrassment to the people we've heard today. The people, of whom today's speakers are representative, and I also would like to include the trade associations, have an educational task ahead of them, and I'm sure they're aware of it.

I can't help feeling some sympathy for organizations like the API and the MCA. I'm sure they're doing their best, and represent the leadership in their fields. And they have their problems, frequently, in persuading their recalcitrant constitutents to wake up and smell the coffee.

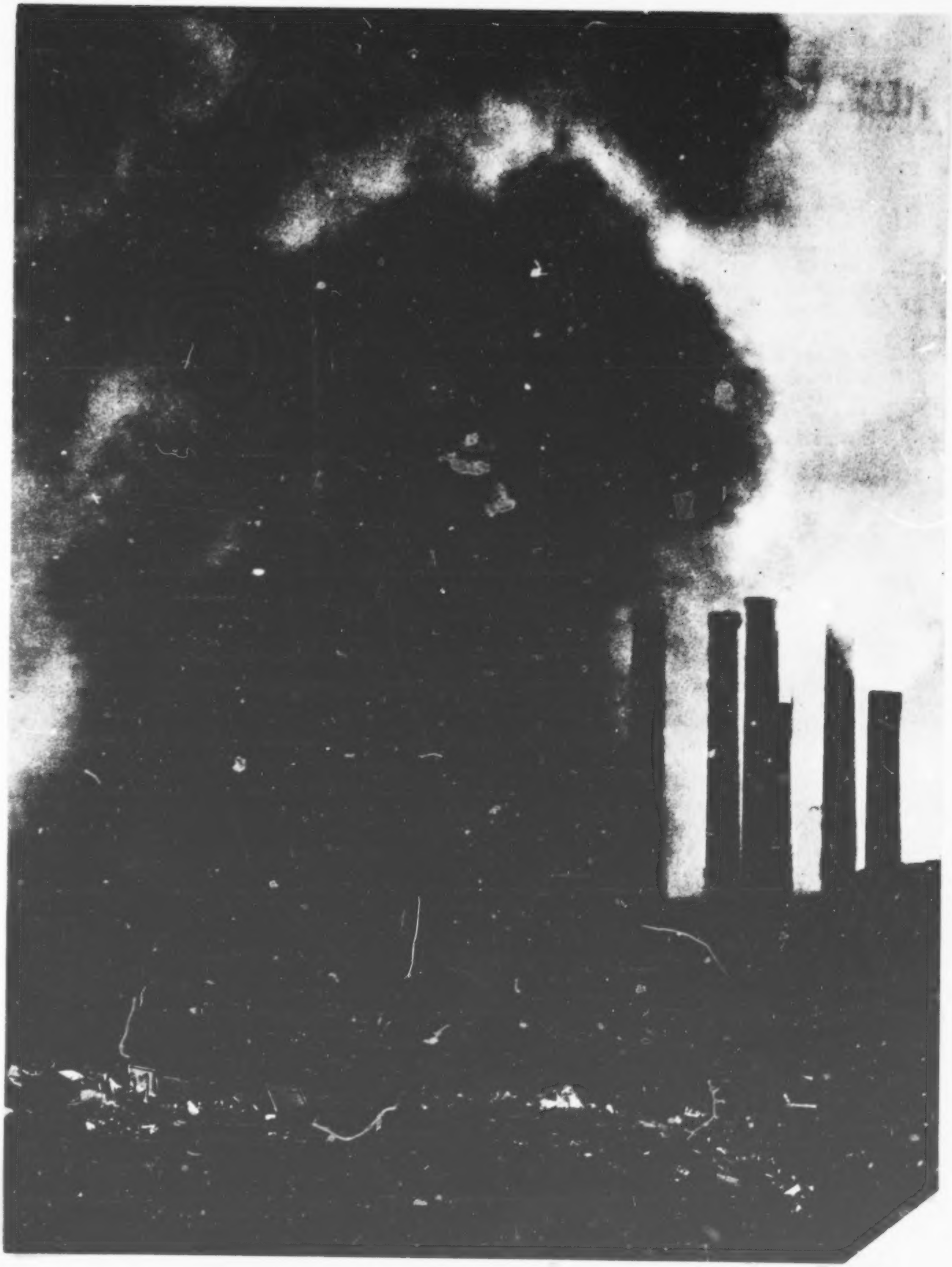
If there is a conclusion that can be drawn from today's proceedings, perhaps it is that not only are there a number of technological corners still unswept —there always are and there always will be—but also that there is still room for some additional maturity. There are still the ghosts of the once-cherished notion that industry has a prior claim on the use of the air. There are still signs of defensiveness, emotional insecurity, and thinly-suppressed paranoia. American industry apparently has still not entirely outgrown what might be called the "nobody loves me" complex.

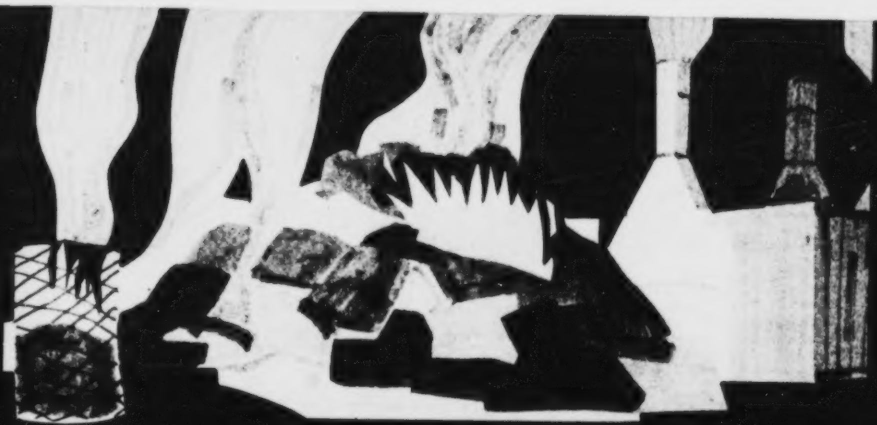
For example, one speaker this morning, in the course of a talk which I considered in many respects one of the most stimulating and provocative here, betrayed this attitude when he complained that the Ford Motor Co. was unfairly dealt with in a CBS television documentary which showed a smoking chimney at a Ford plant. CBS failed, he said, and neglected its reportorial duty to mention Ford's successes and leadership in air pollution control.

Industry must come to realize that it is pointless to whine about this sort of thing. Industry can no longer expect glory and congratulations for its control efforts any more than it can expect applause for paying taxes or providing parking lots for its employees. It can only expect—and society has come to feel that it has a right to expect—that it control pollution as its unsung and essentially unrewarded duty. What it can expect is criticism, and even ridicule, when it is negligent in these matters, regardless of its past record of success.

Industry will know it has arrived at the plateau of success in air pollution control, I submit, when the public and government acknowledge that economic and political aspects have withered away as primary considerations, leaving only the technical matters to be dealt with. And I say that there is a worthwhile objective here for industry.

HELP!!
AIR (COUGH-COUGH)
POLLUTION
KILLS!
COUGH COUGH COUGH COUGH
CINERATION IS OBSOLETE AND A HEALTH HAZARD
OFFIC
AIR PO
AIR POLLUTION. IS NO SOLUTION





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December 13, 1966

PANEL D

SOLID WASTE DISPOSAL

FIRST SESSION

Chairman Abraham Michaels
Consulting Engineer
Philadelphia, Pennsylvania

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". . . consultant on solid waste disposal to many large cities . . . President of Institute for Solid Wastes . . . former Deputy Street Commissioner of Philadelphia . . ."

STATUS REPORT

ABRAHAM MICHAELS
Consulting Engineer
Philadelphia, Pennsylvania

We are principally concerned today with the disposal of waste produced by what we might define as our human society, as opposed to the waste produced by agriculture or the waste produced by mining. It is not that these wastes or the air pollution contribution from these wastes are not significant; it is just that we haven't gotten around to collecting meaningful data about them. Perhaps this is something that we will have to do in the future. In our affluence, we reportedly generate 4½ pounds of refuse per person per day, of the type normally collected for disposal. In addition to this 4½ pounds, there is waste which is produced by industry and disposed of directly by industry, and waste which is disposed of in some instances by the individual, particularly in rural areas.

Actually, some communities have estimated their per capita waste production as high as 8 pounds a day. The basis for the quantities noted are dramatically described in the November 1965 report to the Environmental Pollution Panel, President's Science Advisory Committee Report, entitled *Restoring the Quality of Our Environment* which notes that each year we dispose of "48 billion cans, 26 billion bottles and jars, 65 billion metal and plastic caps and crowns, plus more than one half billion dollars worth of miscellaneous packaging material." Not satisfied with these impressive statistics, we are increasing our capacity to generate waste at a rate of 2 percent per year, which, when coupled with the population growth, results in an annual increase of 4 percent. For a nation of 200 million people, the current refuse generation rate produces 160 million tons of refuse which must be disposed of each year.

I attempted to determine the apportionment of various methods of waste disposal, but unfortunately could find no meaningful figures. I attempted to do this because I felt this would be a good way of evaluating the air pollution contribution from solid wastes and estimating their potential contribution.

Failing to find these numbers, I made some estimates. These estimates first recognize that between one-fourth and one-third of our population still live in rural areas, although this percentage is being reduced rather rapidly. It was assumed that more than half the waste produced in rural areas is disposed of by open burning. This assumption was based on observation.

Studies of incinerator construction records resulted in an estimate that 10 to 15 percent of all refuse is disposed of by incinerators. This includes not just municipal incinerators, but also private incinerators available for public use, industrial incinerators, apartment house incinerators, household incinerators, and hospital incinerators.

TABLE I. PARTICULATE EMISSIONS

Source	Solid waste	Quantity solid waste (tons)	Particulate emission	Quantity particulate emission (tons)
Good incineration	5	8,000,000	1	80,000
Poor incineration	10	16,000,000	2.5	400,000
Open burn, urban	15	24,000,000	4	960,000
Open burn, rural	20	32,000,000	4	1,280,000
Landfilling	40	64,000,000	0	0
Other	10	16,000,000	0	0
Total	....	160,000,000	....	2,620,000

It is further estimated that 20 to 25 percent of all urban refuse is disposed of by open burning. This includes leaves, yard trash, demolition material, bulky refuse, and controlled open burning, generally by municipalities.

Approximately 40 percent of all refuse is disposed of by land filling, both sanitary and otherwise, and 10 percent by various other methods, including hog feeding, grinding, salvage, and reclamation. Of these various methods, only the combustion methods produce air pollution that might be considered significant on a national scale. Certainly, promiscuous dumping produces local odors, but this analysis was made for a national approach as opposed to the local approach. It was estimated, based on theoretical air requirements, that the quantity of particulate emitted by incineration will vary from 10 to 60 pounds per ton of material burned and by open burning from 60 to 100 pounds per ton. Using these estimates, particulate from various disposal methods is shown in Table I.

It is recognized that, in addition to particulate matter, poor refuse disposal by combustion does emit gaseous pollutants, particularly carbon monoxide and hydrocarbons. Other common pollutants such as oxides of sulfur and oxides of nitrogen are not significant because of the chemical composition of refuse. The report of the National Research Council of the National Academy of Sciences entitled "Waste Management and Control" lists the principal pollutants emitted into the atmosphere. Of all the pollutants, 12 million tons per year, or 10 percent, is particulate matter and refuse disposal accounts for 3.3 million tons of pollutants or 2.6 percent of particulates from all sources. This is not a very significant figure. The difference between the 2.6 million reported in our table and the 3.3 million reported by the NAS study can probably be attributed to the carbon monoxide and hydrocarbons emitted from poor combustion practice.

If the refuse that is currently disposed of by combustion were properly incinerated, then—using the figure from our table, of 1 percent particulate emissions*—the total particulate emission from refuse incineration would be 800,000 tons per year, which is under 1 percent of the total quantity of air pollutants currently being emitted into the atmosphere. Even if all the combustible refuse produced in this country were to be incinerated and incinerated properly, or incinerated to meet an emission limit of .85 pound of particulate matter per thousand pounds of gases, corrected to 12 percent CO_2 at standard atmospheric conditions (which would limit gaseous emissions essentially to CO_2 and H_2O), the total particulate emission would be less than 1.5 percent of the total pollution to the atmosphere.

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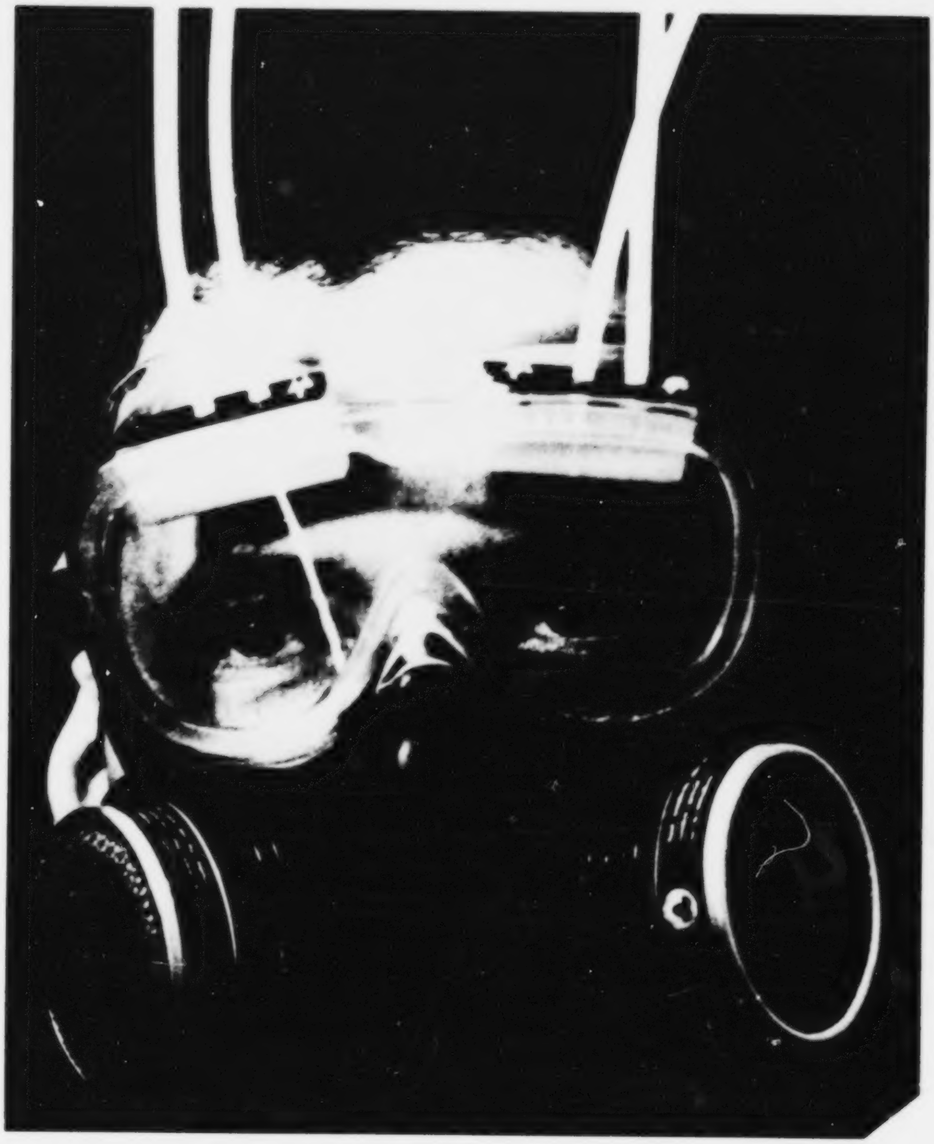
*My colleague, Fred Rehm, says that the true figure is considerably less than 1 percent, but if so, that will make my conclusion all the more conservative.

So the question is raised, why is it necessary for New York City or Los Angeles County or even the Federal Government to reduce particulate emission limits to between one-half and one-fourth of the .85 limit mentioned earlier? One might also, recognizing the small contribution of particulate matter, question the desirability of the New York shutdown of incinerators during the recent smog.

Urban growth will increase the need for incineration as a method of refuse disposal, but the public is generally unwilling to accept incinerators in their communities. The particulate emission table indicates that one-third of our incinerators are operated reasonably well, but we recognize that it takes only one bad apple to ruin a barrel. It becomes easy to understand the public's attitude towards incinerators since at least two-thirds of our incineration capacity is poorly operated.

Our task here today is to examine the present status of solid waste disposal and to set a program for the future. Is the problem in fact one of management? Must we look to alternatives for incineration, or can we legislate the problem out of existence? We, the panel participants, will attempt to arrive at a program which will seek answers to these questions.



". . . civil engineer . . . on University of California's alumni engineering council . . . onetime delegate to WHO . . . former faculty member, University of Texas Medical Branchs . . ."

FUTURE AIR QUALITY STANDARDS AND REFUSE DISPOSAL OPERATION RESTRICTIONS

FRANK M. STEAD
Chief, California Division
of Environmental
Sanitation
Berkeley, California

One of the things that makes a panel discussion of this sort difficult is the fact that we're trying the impossible; we are trying to break the subject of air pollution into eight pieces and discuss each piece separately and independently.

But the problem is more complex because the air system itself cannot be considered as a separate independent system. More and more we are reaching the realization that what we're dealing with in trying to cope with the environment, or manage the environment, is a complex composed of the land system, the water system, and the air system, all mixed together.

If there is one system that is the dominant, one to which the others are subsidiary, it is the terrestrial system or the land system.

We seldom approach our problem on this broad a basis. We usually recognize that there are three subsystems, one of which we call the atmospheric system, and deal with these subsystems one at a time. Then, when we break out of one of those subsystems the waste-management part only and leave untouched the concept of managing the resource system itself (in this case, air), we indeed get into trouble.

We all realize the close relationship between liquid wastes and the water resources; we realize that one can no longer be managed intelligently independent of the other. The same principles apply to air. How far are we from being able to manage air as a resource, i.e., move it from areas of plenty to areas of need? Probably our first breakthrough here will come in improving and modifying the phenomenon of vertical mixture. This is indeed a way to expand the quantity of the resource. How soon will the day come when we can actually either pipe out the aerial wastes or treat the intake air supply as a resource? No one can predict this with respect to its timetable, but one must predict with respect to it, that it is a certainty. Failing this outcome, we should indeed be going down a blind alley.

Every time a representative of that well-known State of California starts talking about California, everyone's hackles go up. They've had just about enough of that! But I am going to inflict a little more of it on you today by way of introduction, because the history of the past 30 years or so in California is a sort of telescoping of the history of the United States. Many of the areas in California first became aware in the last few years of population pressures due to the rapid development of urban areas. Over the past 20 years, therefore, there has been a continual parade of communities and geographical areas and basins that become aware for the first time of the fact that air pollution can become a problem. On the other hand, some of our areas have gone almost to the ultimate, almost to the survival limit of a metropolitan area, with respect to the present management of the air resource. So we have a telescoping of the past and a telescoping of the future of the United States as a whole. Viewed from this vantage point, it is possible to get from the mind and memory of one man (so to speak) the whole perspective; and it is indeed difficult to get it in any other way.

In this perspective, let us consider the sequence of events that a community goes through, from birth to death in developing awareness of an air pollution problem.

When people in an area first realize that air pollution may become a problem, the realization is likely to be brought about by talks made by governmental officials, usually local officials, before their governing bodies, before service clubs, before women's clubs, before conservation groups, etc. Now they know that the problem is coming.

Then usually at about this point a "quick and dirty" survey is made. This, of course, is far more impressive when it is made by an out-of-town expert. If your State capital is far enough away and you bring in a State man, that is often sufficient, but if that is not sufficiently impressive, then you bring in a Federal representative. In either case, you get a survey. Then there's an authoritative statement made: "yes indeed, this community is facing an air pollution problem."

What usually happens next is that the State or local health department makes a friendly gesture and offers consultation to industry and to municipalities with respect to their waste-producing operation. This friendly consultation goes something like this: You knock on the door of the president of this or that company, you introduce yourself, and you say how important it is to get off on the right foot and to maintain goodwill. You promise the industry people that they will get off much more lightly if they cooperate; you assure them that the tolerance of the public is much greater if its anger has never been aroused and that, once you've done the latter, the ground rules are much tighter. You can offer a lot of incentives to "con" them into making earnest gestures of good intent with respect to air pollution.

Then time goes on and the situation worsens a little bit. All of a sudden four or five outstanding instances of pollution from point sources are noted because they are easily identifiable by the senses, either by sight of smoke or the awareness of obnoxious odors or irritating gases. Now a new community, the downwind group that lives in the plume, becomes an aroused group, and the friendly consultation chapter is now closed. You begin to talk about a public nuisance abatement action. This is a fascinating thing in itself because our concepts of public nuisance go deep, through the common law that is part of our Anglo-Saxon heritage. It's one of the most powerful weapons, one of the most powerful forces that can be brought to bear, if indeed the people who complained will carry through, because only they can prove that a nuisance exists. But public nuisance action leaves everyone with a few scars and everyone realizes that this is now a game for keeps.

Then there usually comes, through an action of the governing body, the establishment of a system of inspection and review of every new installation, often in the form of a permit requirement of some sort.

Then, as a few more years go by and the public begins to make itself heard by voicing dissatisfaction with the rate of progress or belittling this much-talked-about air pollution control program that has now been mounted, there comes a cry for a scapegoat.

There must be one. Usually the first thing that happens is that you ban open burning. Open burning has no friends. Neither has an open garbage dump with hogs on it. This is an easy one; you can take this one and not lose any of your friends and it's a pretty impressive thing to do. In our culture of championing the underdog, you pick on the big guys, the city itself; you can't do better than that.

That buys you about one more year of time. But finally you begin to face the real music. If you set up a measurement program—in the first stages, usually measuring the particulate loading in the atmosphere and comparing it to figures from the nationwide network—you realize you've got a real air pollution problem from the presence in the atmosphere of materials which are very objectionable. So you adopt regulations. This is a big step. The governing body adopts regulations for emissions. These first regulations are requirements for good practice. You look all through the trade journals, etc., and you try to apply the yardstick of good practice. If the yardstick of good practice is indeed an unsatisfactory thing, it is still "good practice" at this early stage.

What is good practice, for example, in a hot road-mix plant? Well, 20 years ago good practice was a pretty awful kind of a thing. What is good practice on a tepee sawdust burner today? That's what happens. Time changes these things. So, as time goes inexorably on and as your loading increases at a considerably faster rate than the population increases, you realize that you've got to take another couple of hard turns on the thumbscrews. You come down pretty quickly to regulations of feasibility. This is equivalent to the state of our current capability. Frequently these regulations come out in terms of maximum permissible grains of emission per ton of material processed or something of that sort.

When you've reached about this point, you realize you've got more than the loading of the air with primary pollutants; you've got secondary reactions in the atmosphere; the photochemical monster has risen to plague you. Finally, at long last, you begin to tangle with man's prize possession, his motor vehicle. You tangle with it. You first go for the good practice and then you go for the feasibility and you come up against unmoving inertia when you seek to develop a feasibility yardstick for something that has never had one before.

What does this mean? This is an empirical approach. This is trial and error. This is moving into the business of regulating air pollution on a basic assumption that simply is not so. The basic assumption is that business can go on as usual. We can do all of the things that we would normally do if we didn't have an air pollution problem. We can have all of the system, all of the technology, and all of the particular patterns of choice selected entirely on the basis of the least cost to the user, with air pollution not a consideration. You can have all of these things; i.e., you can have your cake and eat it too, if you will apply continually more severe controls to this system.

As I tried to indicate, this system is a one-way road to trouble because you made a guarantee that you had no right to make. You're proceeding without knowledge of what the real environmental system is that you're dealing with. Your attention is entirely on inputs. You don't know the size or the method of operation of the system, and particularly you don't know anything about its outputs, the total recycling. So that you're continuing to fill the bucket without any forethought of how you will develop a steady state, without any knowledge of the long range steady-state assimilative capacity of the system that you're loading up.

Furthermore, and more disastrous even than that, we are proceeding with no guidelines. This is the most fantastic part of it all. We have no guidelines as to objectives in the form of final environmental quality. We have proceeded for 50 years on the assumption that what we call public health standards are sufficient guidelines. Everybody but the health department knows that these guidelines are not enough because the scientifically honest public health people staunchly say, as we heard yesterday afternoon, that to be responsible and honest we've got to say that it's hard to find the bodies. And until you find the bodies, the corollary is that you have no right to apply a public health sanction against a public health threat that doesn't exist, so the air pollution goes on. Everybody knows what is going on, but we have given ourselves these strange handcuffs.

The failure to have clear, well-understood, and well-appreciated environmental quality standards to which we can design our program is perhaps the worst disaster of all. The sum total of this is that we have given our citizens, our city officials, and our industrial friends a tacit assurance that if they will go with us we will get through this valley of shadows with the existing systems.

This is not good faith. Sooner or later the piper has got to be paid and that's the time to retire.

All that came straight from my heart, not from my prepared paper. The paper is the center part of my sandwich today, but fortunately, it is very brief and I will read it rapidly.

One of the most perplexing aspects of air pollution in the United States is that it is so many things to so many people, and when we discuss air pollution on a national scale, we find ourselves in the situation of the three blind men attempting to describe an elephant. One, bumping into its side, said that an elephant is like a wall. A second, feeling its leg, said that an elephant is like a tree; while the third, grasping its tail, was sure that an elephant is like a rope. Air pollution does, indeed, have many manisfestations.

SPECTRUM OF EFFECTS

The effects of air pollution may be thought of as a series of environmental penalties which deprive society of the full benefits of the air resource. Starting with the most drastic, we have a level of public health disaster. At this level, air becomes unbreathable, is asphyxiating or, through the process of respiration, introduces into the human system toxic compounds in lethal concentration. Next, comes a degree of opacity in the air which so curtails visibility as to bring all transportation to a halt. Third, comes a whole array of chemical and physical reactions between the air and private property—be it animate, as in the case of agricultural crops, or inanimate, as in the case of buildings and automobile tires.

Finally, come those levels of air pollution which, while not lethal, directly and adversely affect the welfare of human beings. These are the levels that make air pollution the overwhelming social problem that we know it to be. The first of these people-impairing levels marks the threshold of those situations which, on continued exposure, can produce impairment in body function, or can shorten life. Next is a level at which human comfort is destroyed and last comes a level of air pollution too mild to do any of the things I have just mentioned, but which simply destroys the scenery.

The air pollutants with which we deal do not sort themelves out neatly accordingly to these six kinds of effects, but if we are to design programs to protect the public interest, we must think in terms of effects rather than kinds of air pollutants.

PRESENT STANDARDS

Strange as it must seem to any person with a philosophic turn of mind, this country has no rational and orderly set of standards for the ambient air. The closest that we come to such standards are the industrial MAC's (maximum allowable concentrations) which over the years since World War I have been developed and used for workroom environments. But neither these standards nor the data upon which they are based are transferable to the ambient air.

In 1959, at the behest of the legislature, the State Department of Public Health in California developed standards for the ambient air, and a beginning was made. Just what was the nature of these California ambient air standards and what impact have they had?

The standards are set at three levels. The terminology is interesting here; don't ask me to explain where the words came from but these levels are called "adverse," "serious," and "emergency." In the categories of effects which we have just discussed, the adverse standard attempts to define a level of air quality which prevents all of the effects referred to except impairment of the scenic vista. The serious-level standard is geared to the threshold of health impairment if exposure is extended or continuous, while the emergency-level standard is to all intents and purposes a public health disaster standard.

IMPACT OF STANDARDS

The standards, as you know, are far from complete from a technical point of view, but they have had a historic impact from a social and political point of view and this in spite of the fact that they are not legally binding upon local air pollution control programs. The mere enunciation of the three levels has required every local governing body and air pollution control agency to recognize that it must eventually decide on the objective of its program in terms of effects of the resultant ambient air quality upon the entire community, rather than to maintain a program of regulation of emissions based upon "state of the art" or political expediency.

So far, although not set forth explicitly in policy statements, every air pollution control district and county governing body in California has tacitly supported the adverse-level standard.

But these steps mark only the opening skirmish in a long campaign. Before we can say that this country has an acceptable air pollution control effort, we must agree firmly on the objectives to be achieved in our metropolitan and open regions—and these objectives may not be identical—and enunciate standards of air quality which match these objectives.

POLLUTANTS AND SOURCES

Having focused our attention on the objectives of air pollution in terms of effects on the population, let us now try to relate these effects to broad groups of air pollutants and their sources.

If another public health disaster occurs in the United States other than as the localized effect of an accident, it will almost certainly result from sulfur dioxide (or SO_2) or carbon monoxide. The sources involved here are predominantly power generation and motor vehicle exhaust. Opacity of the atmosphere severe enough to bring transportation to a standstill would be due to aerosols and here the principal sources would be smoke from inefficient combustion, dust from natural sources, and aerosol produced in the photochemical smog reaction as well as from the oxidation of sulfur dioxide in the atmosphere.

Physical property damage results from deposition of dust and soot. The far more pervasive chemical property damage which, by destroying vegetation, plagues the West, however, results from the oxidants produced in the photochemical smog reaction. Here homes, industry, and motor vehicles are alike implicated.

Chronic health impairment points the finger at such chemical agents as irritants (sulfur dioxide, nitrogen dioxide, and oxidants) and toxicants (carbon monoxide, lead, and carcinogens). The predominant source here is the internal-combustion motor vehicle and the industry that furnishes its fuel.

Destruction of comfort results from odors and irritants. Consequently, the predominant sources are organic wastes, liquid and solid; industrial gaseous emissions, and the photochemical oxidants. Finally, destruction of scenic values results from color or light obstruction by gases and aerosols at levels far below those which produce the effects previously mentioned. The sources of pollutants capable of producing this effect include all of those which have been enumerated, together with the aerosol contained in the products of even the most complete combustion of solid or liquid fuels.

REFUSE DISPOSAL IMPLICATIONS

From the foregoing, it is apparent that the significance of any activity such as refuse disposal on air pollution depends on the effect one is concerned with. If the only effects of concern are prevention of public health disasters, transportation shutdowns, property damage, and chronic health impairment, then one could conclude that refuse disposal plays a relatively unimportant part in producing air pollution. If the preservation of human comfort is considered important, then disposal of refuse by conventional methods is an important contributor to air pollution.

Present methods of disposal of refuse by sewage treatment processes, land disposal, and open burning at either the city or the household level, all have an impact on comfort by discharging obnoxious smokes and odors into the ambient atmosphere. But the decision has already been made that refuse disposal will no longer be permitted the privilege of placing these burdens on the air system. The new Federal Water Pollution, Air Pollution, and Solid Waste Acts have all in effect demanded that waste-disposal activities throughout the Nation be upgraded to the no-nuisance level. So this degree of refinement in control of emissions is a national policy already behind us. It is merely a question of adhering to it.

If, therefore, comfort is the highest air quality objective, refuse disposal need not and will not impose a restriction on air pollution programs since the technologies of liquid waste treatment, sanitary landfill, and incineration are each already capable of operating economically within this restraint.

The crux of the matter rests upon whether the preservation of human comfort and protection of human health and the prevention of property damage constitute the total objectives of the air pollution program, or whether the preservation of the scenic values of the environment is the final objective.

PRESERVATION OF AN ESTHETIC ENVIRONMENT

Only the people can decide whether the objective of air pollution control shall be to preserve the scenic value of the cityside and the countryside. The decision will not be made suddenly, but step by step as the issues emerge and are put to test in our political system. He who follows the trend of recent popular decisions in this field cannot escape the strong prediction that the rising public aspiration for an attractive and enjoyable environment will in the end prevail and that preservation of transparency of the atmosphere itself will become the law of the land.

If this happens, then present technology of waste disposal could indeed be a restriction. But I do not believe that this is the final answer. I am convinced that sparkling clear air will be the independent consideration to which all other considerations, including present technology, must yield. I predict, therefore, that a technology of refuse disposal will be developed within the next five years which makes no detectable change in the appearance of the ambient air.

In conclusion I would like to state that it's trite to say that one must apply the systems approach to a system of this complexity, but it's necessary to say it. In the systems approach these words mean many things to many people and the approach itself has many aspects. But it has certain germ or inherent ideas which are unique, or at least unique to our experience. The systems approach, particularly as it was developed in the aerospace industry for the production of weapons and space vehicles, has first of all the concept that one begins with a clean drawing board, with nothing on it. And first of all one establishes the objective of the desired weapon or vehicle, its characteristics and its performance attributes. Then, working back from that end-result which has been established at the outset, it next establishes the timetable in the form of a pert chart to indicate when different pieces of information and other elements must be ready. Then, where the links are missing, it calls for new hardware and new technology on a demand basis.

It has been demonstrated so that it now can be a faith that we can apply, I believe, to virtually any part of our technology. If we first state the objective and then call for the technology and the hardware, with a reasonable time table—this means a lead time sufficient to do the job—then we do not continue to proceed by trying to make improvements on an existing system which may perchance have already outlived its usefulness.

So the setting of the objectives and the producing of the elements that go into the problem is one of the concepts of the systems approach. Another concept of a systems approach is a complete knowledge, first of all, of how big the system is in order that it may include not only all of the environmental zones of influence, but may include as well the political and economic zones of influence. A system must be big enough so that within the system you have enclosed all of the factors needed.

". . . former plant engineer for Pullman Company . . . assistant to commissioner of buildings, Chicago . . . directed Chicago's air pollution control program . . ."

DISCUSSION

SOLID REFUSE DISPOSAL PRACTICES AS RELATED TO AIR POLLUTION PROBLEMS

JAMES V. FITZPATRICK*
Commissioner of Streets
and Sanitation
Chicago

As Frank Stead has so aptly described, there is considerable information that clearly substantiates the assertion that air pollution is highly detrimental to the health and welfare of human beings in many sections of our country. It was further implied that the solution of this gigantic problem will ultimately lie in the formulation of adequate air quality standards and their rapid achievement.

No doubt this is true, but air quality standards are very complex, mainly because there are a multitude of factors contributing towards overall air pollution. For example, air quality is influenced by emissions from fuel consumption, from industrial activities, from transportation patterns, and, of course, from solid waste disposal practices.

Due to the increasing density and affluence of the population in urban and suburban areas, disposal of solid waste generated by these people has become a critical problem. Total production of solid waste in the United States has been estimated at 167 million tons in 1966. By 1980 the projected estimate is 260 million tons. This represents a rise from approximately 4.45 lb. per capita per day in 1965 to approximately 5.5 lb. per capita per day in 1980.

Already, volumes upon volumes of data are available regarding pollution from fuel consumption, industrial activities and transportation. However, since the theme of today's discussion is pollution from solid refuse, I plan to confine my remarks to the relationship of solid-refuse-disposal practices as they are conducted in Chicago to the overall air pollution problem.

What is the solid-refuse problem for Chicago?

Recently, a solid-refuse survey was completed which showed that more than three million tons of refuse are generated in Chicago annually, approximately 4½ pounds per capita per day.[1]

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*Delivered by Melbourne A. Noel, Engineer of Sanitation, Chicago.

[1] Solid Waste Estimate Study for the City of Chicago Department of Air Pollution Control.

How was this ultimately disposed of?

An estimated 600,000 tons were burned in private coal-fired stoker boilers—another 400,000 tons were burned in private incinerators, over one million tons were disposed of in sanitary landfills and the remainder, approximately 800,000 tons, were burned in municipal incinerators.

Disposal of these quantities accounts for an estimated 16,000 tons of particulate emissions discharged into Chicago's atmosphere every year.

Municipal incinerators account for less than one-third of the total emissions, despite the fact that almost half of the solid waste disposed of by burning was in municipal facilities.

Burning of solid waste in coal-fired stoker boilers is considerably less efficient than in incinerators, and increases the grain loading in stack emissions. This type of boiler is found frequently in apartment houses of five to eight units.

Studies have shown that, by the year 2000, the population in the Chicago Standard Metropolitan Statistical Area will be approximately 10 million persons. By that time, the generated refuse on a per capita basis in Chicago is expected to increase to 5½ pounds per day or greater.

How will the increasing solid waste disposal problems be handled in relation to the air pollution peril? In Chicago, we are meeting the problem head on. We are looking ahead to legislation, new techniques, and the building of additional modern incinerator facilities.

The City of Chicago has increased its refuse collection service in the past year and now provides twice-a-week pick up in several hundred blocks where there is a high population density. Our Bureau of Sanitation also maintains a regularly scheduled citywide bulky-trash-removal program. During 1966 the city will collect an estimated all-time high of 1,004,000 tons of refuse, in addition to 300,000 tons of bulky trash.

The City of Chicago provides free solid-waste-removal service for private residences and for buildings with four apartments or less. The City Code requires that larger buildings and commercial units engage a private scavenger service to remove refuse.

Chicago embarked on its incinerator-building program in 1954, when it began construction of the Medill Avenue plant, which has a capacity of 750 tons per day and is located on the northwest side of the city. The Calumet plant (1,200 tons per day) was built in 1958. A third incinerator, the Southwest, was put into operation in 1963. It too has a capacity of 1,200 tons per day.

In designing these plants, Chicago tried to find the best and most modern method of handling the refuse and residue, the most advanced type of furnace, and a good air pollution control device.

Refuse is deposited onto an enclosed tipping-floor area in all plants. This is done to alleviate dust emission from dumping. Dust from the pit area is greatly alleviated by water sprays and by using the tipping-floor area as a plenum chamber for supplying combustion air to the furnaces through openings in the pit wall.

The residue from the plant is removed in enclosed bath-type drag-link conveyors. This again alleviates emissions of dust from handling of residue. Air pollution control is effected by use of dry settling and a wet scrubber chamber in each furnace to control particulate in the plant stack emission.

The results of the stack analysis made at the City's Calumet Incinerator by a private testing firm revealed that with a floor pond and five spray heads, each of a 10 GPM capacity in operation, flyash and particulate emission was reduced by 84 percent below the requirements of the Chicago air pollution ordinance, or .0796 grains per cubic foot at standard temperature and pressure.

In addition, during the whole week of tests, there was no smoke observed that could be assigned a Ringelmann number of 1 or over. This again, was well within the air pollution control limitation.

Sieve particle-size analyses were made of the sampled particulates on two dust test runs. Microscopic analysis of the bag and flush material showed that the particulate, with only a minor exception, were below 44 microns in size. Most particles collected in the bag and flush jar were also below 10 microns in particle size.

Other interesting factors derived from the test showed that the furnace units had an average for all runs of 9.67 pounds of gas per pound or refuse destroyed. This indicates that the furnace units were tight, with a minimum of air infiltration. Also of interest was the the result of the test on the effect of water sprays on CO_2 absorption. Analysis made it apparent that no significant amount of CO_2 was removed from effluent gas streams by use of wet-collector chambers.

Stack height is an interesting facet in the air pollution control field. Some experts feel it is an important factor; others do not. However, it is our opinion that stack height, together with local meteorological conditions, is an important factor in defining the location and amount of dustfall and the concentration of suspended particulates near the ground. Among the established emission standards, very few include effective stack-height factors. The Chicago Ordinance covering particulate-matter emission standards has a rectifying equation for stack height which increases the emission by

$$.03 \times \frac{(H^2}{100} \text{ grains/cu. ft. (STP).}$$

All the increased grain loading allowed by the stack-height formula must be under 10 microns in size.

West Germany has incorporated stack-height parameter in its emission specifications for particulate matter from combustion sources. Belgium and Great Britain also have stack-height factors in their ordinances for regulating sulfur dioxide emissions.

In considering future restrictions on refuse-disposal operations in Chicago, insofar as their quality control is concerned, one can envision certain design and operation requirements in incinerators being rigidly enforced. Improvements will be necessary in furnace- and material-handling design. In addition special instrumentation for continuous temperature, gas and particulate weight analysis will be needed.

Equipment for the continuous observation of particulate fly-ash loading has, as yet not been perfected. In the near future, a continuous monitoring device for particulate weights will be tested at Chicago's Southwest incinerator.

For the last few years, the American Public Works Association, the Illinois Institute of Technology and Research, and the U.S. Public Health Service have been working on the development of this monitoring equipment. If it proves to be serviceable, an important adjunct will be made available to analyze gas emissions from burning of solid wastes.

With the passage of a $15,000,000 bond issue last summer, Chicago is now preparing to build two new incinerator plants. The design of one is now underway. It is hoped the ground will be broken for construction by mid-1967.

From preliminary design consideration, this plant should be one of the outstanding facilities in the country. Under present plans it will be a 1,200-ton-a-day plant, generally similar to our present Southwest plant. As planned, it will have four 300-ton furnaces with a number of improvements scheduled to be made in furnace design as compared to those in the City's other plants.

The changes should help lower particulate load in the gas stream by more efficient combustion of volatiles. From an air pollution standpoint, a change is contemplated in the type of equipment to be used for this purpose in the new plant.

Present planning envisions a combination of a wet scrubber and an electrostatic precipitator. This combination should cut grain loading, as sampled, to approximately .05 to .1 grains per cubic foot (STP). The additional cost for the change in air pollution control will be approximately $600,000 for the plant. However, information derived from the operation of this type of collection method will be of great value in future plant design.

The City has given a great deal of thought to the sizing of refuse before burning. To get firsthand knowledge of this type of treatment, we are now planning to build a grinding station for the experimental sizing of refuse and the reduction of combustible bulk material. With the sizing of refuse, a complete change in plant design could be utilized. Design of the furnaces would also vary, as the calorific value of refuse would be more concentrated, with the as-fired value of the Chicago material raised from approximately 4,000 BTU's per pound to 5,000 to 5,500 BTU's per pound. The foregoing will necessitate an improved type of furnace design, so that higher operating temperatures may be handled. Lowering of the grain loading in the furnaces' gas emissions can also be expected.

It is quite apparent that the cost per ton for plant construction and operation would increase with the above requirements. An increase in skilled personnel will be needed to handle the more sophisticated plant equipment. In some localities, this may place a budgetary restriction on future plant construction and operation.

We recognize that many of the air pollution problems in the Chicago area are not common to other sections of the country. However, many of the methods and techniques applied in combating these problems are familiar to all of us.

In Chicago we are always seeking new ways to approach the problems of solid-waste disposal in relation to air pollution. I have appreciated this opportunity to give a few brief comments on Chicago's progress in its program to achieve a high standard of air quality.

". . . sanitary engineer . . . leading role in national environmental programs since 1954 . . . helped organize federal pollution control programs . . . formerly supervised PHS control programs in malaria and dengue fever . . ."

THE IMPACT OF THE SOLID WASTE DISPOSAL ACT

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I am particularly glad to participate in this National Conference on Air Pollution and for a very special reason. This one, as distinguished from both previous conferences, has a panel on the subject of solid waste disposal.

This suggests that we may no longer compartmentalize these high-level discussions of pollution problems. It suggests that we may look forward to in-depth consideration by qualified authorities of the relationships between methods used to dispose of garbage, refuse, and junk, and the pollution of the air and water phases of our environment.

A major concern of this panel is how to incinerate solid wastes without worsening air pollution. Of course, this is a national problem, which the New York air emergency so dramatically localized some two weeks ago. And as that emergency painfully demonstrated, an air pollution alert may be followed by a new crisis as municipal incinerators are shut down and the garbage piles up in huge quantities.

The solid-waste sequel to New York's air pollution emergency forcibly reminds us, furthermore, that accumulation of refuse on the land may also seriously pollute—and has polluted—water.

My assignment here is to talk with you about the impact of the Solid Waste Disposal Act. The law is a little more than a year old now. It has had, and I suppose will have, many impacts. But it seems to me that the Act's most important impact has been the degree to which it is required that we give consideration to the fact that land, air, and water pollution problems often are indivisible. Now a great city's ordeal of pollution gives this fact new visibility.

It can hardly be stressed too frequently that land, air, and water are at once receivers of waste and reservoirs of resources essential to life. Nor can it be emphasized too often that they are interconnected and that to pollute one may mean to pollute all three. Their volume has been fixed since human beings first began to dispose of wastes. Of course, these reservoirs are vast. But they are no more endless, although often so considered, than are the waste-stowage compartments on a spaceship.

We must discuss pollution abatement with the awareness of the interrelationships between problems in the air and on the land. But, more important, we must execute our abatement responsibilities to give effect to our recognition of the interrelationships among all three of the pollution areas. As we thus act, we must keep in mind the fact that the great mobility of air and of water compels us to focus more and more upon the land in our search for sinks or repositories for ultimate waste disposal. The Solid Waste

Disposal Act makes it possible, to the extent of Federal authorization, to relate solutions for land pollution problems with those for air and water. This is its basic impact.

The Act has been called the child of Federal air and water pollution laws. The child, it may be added with equal truth, is a most welcome, necessary, and long-overdue addition to the family of Federal statutes for the protection of health and of our environment against contamination. Federal air pollution legislation has been on the books for about 11 years. We have had Federal law on water pollution for about 22 years. Now, for a little more than 13 months, we have had a law which represents the first substantial Federal commitment for a national program for meaningful health management of municipal, industrial, and agricultural solid wastes. I might mention here that this particular Act is the only one in which there is specific mention of the fact that these other pollution areas actually exist and that therefore there is an interrelationship among all three.

The program is under way in many parts of the country. Public agencies at local and State levels, where waste collection and disposal responsibility primarily remains under the Act, are the principal program participants. Private agencies and industries are also active and are becoming increasingly involved.

The Federal Government in the sense of the present Act is chiefly a supporting partner in the program. Two Federal Departments bear this partnership responsibility. The Department of the Interior aids in solving solid-waste problems resulting from extracting, processing, or using minerals or fossil fuels in those instances where waste generation or reuse may be controlled by the extracting, processing, or using facility.

All other responsibilities were assigned by the Act to the Department of Health, Education, and Welfare. They were delegated to the Surgeon General of the Public Health Service and redelegated by him to the Office of Solid Wastes. Since then, Public Health Service staff members have been moving ahead rapidly, and with strong assistance from public and private non-Federal agencies, in five areas of activity.

The first is in research. Thirty-one grant research projects have been started, direct research capabilities have been established, and contracts have been and are being negotiated with industry and other private organizations for new data and for innovations in waste-management technology.

In the second area of activity, 26 projects have begun field studies of improved approaches to solid-waste management and demonstrations of new and improved solid-waste technology with two-thirds grant support. I should like to emphasize what we believe to be an extremely important concept in the demonstration of application of the knowledge obtained from the research programs. In no other area is there a clearer need for shortening the time lag between the research bench and everyday application.

In the third category of activity, 21 States have received 50-percent grant support for surveying solid-waste disposal needs and for developing Statewide and regional programs for meeting those needs. A year ago about 6 States had identifiable solid-waste programs. Now there are at least 21 State-level programs, mostly in health departments.

Grants have been approved, in the fourth activity area, for nine institutions of higher education to strengthen the solid-waste training of graduate students in engineering and science to alleviate shortages of technical personnel. Meanwhile, PHS training programs are being conducted to remedy critical shortages in solid-wastes technical, operating, and administration personnel.

As the fifth principal solid-waste activity, PHS engineers and scientists work with non-Federal agencies on technical problems, including criteria development.

To date, the combined financial commitment of the two departments is about $25 million, but this sum, plus related expenditures by local, State, and private agencies, can amount to no more than a fraction of the investment in equipment- and operation-improvement which modern waste-management practice requires and which has been so long postponed.

For solid-waste research alone, according to one expert, this country ought to be spending about $100 million a year. This is more than seven times the $14 million spent or earmarked for research by the Interior and Health, Education, and Welfare Departments in the fiscal years 1966 and 1967.

Whether measured in terms of research dollars or total dollars, the solid-waste program must be ranked well below commitments for progress in virtually every other important field of national endeavor in the United States.

This backwardness, especially marked in research and technological development, has been blamed upon public indifference. People had little interest in disposal problems as long as refuse was collected regularly and there was no apparent health threat from disease-carrying rodents and insects swarming through the open dump or from noxious vapors pouring from the old incinerator.

But public attitudes toward solid wastes are changing. A steadily rising volume of articles in the Nation's press makes that clear. In fact, when the Solid Waste Disposal Act was adopted in October 1965, many people and many members of the Congress had to be at least concerned about across-the-country blight from the open-burning dumps and obsolete incineration. Now it is plain that we have, as an impact of the Act, a public demand so universal as to amount to a mandate that health-endangering and environment-contaminating solid-waste mismanagement be replaced by environmental-management practices of the highest caliber.

There is one particular part of the Act[1] which could be interpreted as expressing the wish of Congress that waste management in all areas of pollution control (air and water as well as land) be worthy of a country as advanced technologically as ours is. I refer to the Act's requirements that States, to be eligible for Statewide survey and planning grants, must show that they intend to improve solid-waste disposal practices without compromising excellence in air- and water-pollution abatement. The Act also requires that plans for interstate and intrastate solid-waste programs be consistent with planning for needs in public health, urban and industrial development, and land use.

The Solid Waste Disposal Act has another impact, perhaps more in spirit than in letter, which obliges all of us to be concerned that pollution control shall excel in performance while we coordinate our control planning with plans for meeting a broad spectrum of other human needs.

Neither the American people nor the Congress are going to be satisfied with parochial approaches to pollution problems, nor patient with second-rate operations. If our friends in the public and in Congress sometimes seem to be in a hurry for results, perhaps it would be all right to recall the years of delay already experienced in efforts to improve the quality of the air and the water sectors of our environment.

No one in solid wastes or related areas of pollution control dares to accept less than the highest standards of performance or the most effective coordination of planning. All we need to do to convince ourselves of this truth is to shut our eyes momentarily to the contamination problems and to consider the collection and disposal of solid wastes only as a materials-handling problem.

Our estimates of waste generation never have permitted self-delusion about the staggering dimensions of the quantities of waste materials being collected and transported in this country. But now we are getting some new solid-waste basic data. Preliminary figures indicate that earlier estimates of solid-waste burden were low, mainly because the data referred onlv to routinely-collected refuse.

Current figures show that the per capita generation of solid-waste discards averages between 5½ and 6 pounds per day, excluding disposal on site in industry and agriculture. Moreover, this does not include the solid wastes extracted from the air and the liquid waste streams, which can be very substantial amounts. And the quantities, of course, are still going up.

We have estimated the worsening materials-handling problem represented by increased generation of a common waste material—fly ash—in a town of 100,000 people. The fly ash load in such a town would run at a daily rate of about 30 tons a year. This will rise to 37 tons a day by 1975, not only because the town will have grown, but also because more fly ash will have been derived from powerhouse stacks as electricity generation by steam increases. This represents a nine-year rise, for one town, of 23 percent in the physical burden of a single element in the solid-waste conglomeration.

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[1] The Solid Waste Disposal Act Sec. 206(b)(2) of the Solid Waste Disposal Act Title II of Public Law 89–272, 89th Congress, S. 306 October 20, 1965.

But estimates of the physical burden of solid wastes tell us nothing about the standards of excellence required to prevent garbage, refuse, and junk from poisoning the air because of antiquated or inadequate incineration or from polluting the water by reason of unsanitary disposal on land. Nor do our estimates indicate the level of environmental management performance necessary to meet a new solid-waste threat as extraction efficiencies increase and more pollutants from air and water have to be deposited on the land.

What we now know about the toxicity of these pollutants makes it clear that we will have to develop and manage technology more advanced than that represented by many presently available disposal procedures to prevent improved air and water cleanup from increasing solid-waste health hazards and land contamination. Great challenges may be posed by the need for safe disposal on land of complex chemical compounds with varying degrees of toxicity for man, domestic animals, or wildlife and, in a few instances, a capability to produce cancer.

However high the standards may be for progress in solid-waste technology and operations performance, someone sooner or later has to answer critical cost questions. And before he can evolve meaningful solutions, he must make a reasonable compromise between the ultimate in environmental quality in all the main sectors—land, air, and water—and revenue availability.

He also must make acceptable allowances for present and future values to society of quality environments.

Not all of the equation elements, however, are known now or can be derived even from available information. But there are, of course, some very interesting kinds of figures from current experience, such as the 18-million-dollar annual increase in solid-waste expenditures estimated for New York City when apartment-house incineration restrictions go into force.

This suggests that we ought to have a truism for people everywhere who are concerned about, or working for, improved pollution control. The truism is that a problem solved in one sector of the environment—land, air, or water—may not solve the problem if it merely shifts the pollution into another sector.

The time has arrived, if we are to protect and improve the health of man and other beneficial life, for us to stop shifting pollutants among sectors of the environment without careful assessment. Our ideal recourse is to recycle or reuse waste unless it can safely be deposited on the land as unusable residue. There are pros and cons to the recycling of matter, but in many ways we are doing some of it right now. Waste water is being recycled to some extent. The chemical and petroleum industries, among others, recover and recycle certain gases and solvent vapors. Steel and paper industries also provide some examples of solid-waste recycling.

The lack of readily identifiable opportunities to profit deters private industry from risking financial resources in research to develop a capability either to recycle wastes or to achieve a substantial reduction in their generation.

However, I know some industrial concerns—and I would like to know more—which have identified new profit opportunities through waste recycling and through innovations in converting, in reducing the volume of, and in transporting solid wastes. Some have made other new contributions to solving solid-waste pollution problems on their own initiative, with their own risk money and with an ingenuity worthy of U.S. technology.

There have been no developments in solid-waste recycling comparable to the recycling of waste water. But there is no reason why companies (for example, those with experience in advanced recycling technology) could not contribute ideas for processes which would, as in the steel or paper industries, recycle solid wastes so that they may become materials for the manufacture of new products and new useful compounds. Eventually, we must be able substantially to improve our technology in order to use wastes in such a way that they can be either intermediate or final products. Composting is often referred to in this connection.

Composting, as its technology is improved, offers a prospect for healthful use of solid wastes in certain special agricultural connections, in raising of ornamental plants, and in certain areas where soils need conditioning. But a Nation with 75 percent of its population living in urban areas, rapidly becoming more urbanized, and generating staggering amounts of solid wastes at rising rates, urgently needs technology for mass reduction of wastes, and composting cannot meet this need. Prospects for meeting it, however, may be found, in part, through some of our PHS-supported research and demonstration projects and, increasingly, in industry activity.

Before discussing mass reduction of wastes, I want to get briefly into the question of producing less waste. Government and industry could do more than they are now doing to reduce waste generation. It would be helpful, for example, if government as a buyer and industry as a supplier could develop ideas for products designed to generate less waste because they could be used longer before discarding or because they produced less waste to begin with. A good place to start would be in packaging where the need is for less bulk and easier disposability.

Combinations of foil or metalized plastic with paper undoubtedly have sales appeal. Aluminum, plastic, or glass nonreturnable containers doubtless have consumer convenience, but they also represent serious solid-waste management problems. Those which are incinerated may contribute to air pollution. Those which must be disposed of on land remain in the environment for centuries.

Ideal containers or packaging would be made of materials which could be incinerated without worsening pollution or deposited on land where the solids would change into substances which the environment could assimilate without harm. That such containers and packaging might be developed is suggested by the fact that we have had available for years a film-forming material which can be washed off and disposed of in water. This can be handled without any water pollution problems. It could be a valuable tool.

When I brought this matter up in a meeting in Geneva last week, I received afterward a small message from the Russian member of the group. He had drawn a picture which showed a bottle labeled "vodka," and the neck of the bottle was bitten off at various points. A little label on the side said "drink and have a bite." That was a disposable container, sure enough.

Government and industry must accept more responsibility for, and devote more resources to, mass reduction of solid wastes. Government and industry could, for example, do a better job in salvaging reusable metals, glass, plastic, and other materials now piling up as solid wastes. Salvage might be accomplished in many cases by adaptation or improvement of existing separation and reprocessing technology.

Government and industry might also make wider use of available methods and develop new methods for heat conversion of wastes into usable carbon, tars, and chemicals. Present or developing technology might be employed in using solid wastes as fuel for waste water purification or to generate power to desalinate sea water for a portion of the daily fresh-water requirements of some cities.

It is interesting to note that refuse has a lower sulfur content than most currently used fuels and hence the use of solid wastes as fuel reduces the problem of removing sulfur dioxide from the waste streams before they get into the ambient air.

Government agencies and industry must apply more effectively than they do today new computer-oriented analysis techniques in developing improved solid-waste management systems. These techniques, most highly developed in public and private aerospace organizations, are greatly needed in sorting out and evaluating the multitudes of public health and other factors involved in developing economic regional and interstate disposal systems.

When we apply systems analysis to the environmental field there are certain major differences from those in space technology. First, in this field we are not starting from scratch. We have tremendous investments in capital facilities which have to be brought into the picture. Second, political and social factors are very important.

Dispersal of solid-waste responsibility among agencies too small to undertake the larger-scale operations necessary is a major reason for the prevalance of unsanitary and landscape-disfiguring disposal practices in this country. I believe that State agencies working with the local areas have an important responsibility in achieving a regionalization concept.

Public Health Service research on systems analysis and related problems is getting under way. One project is evaluating factors involved in developing a regional system. Another is developing a mathematical model for obtaining data for a systematic management of refuse disposal in a large city. There are still others; one is designing a model for estimating air pollution and operating costs of proposed systems using solid-waste incineration.

Techniques of mathematics and systems analysis must be most resourcefully applied if government and industry (and I mean farming in the industrialized sense, as well as manufacturing) are to fulfill the country's expectations that workable answers soon will be produced for the complex air, land, and water pollution abatement problem.

We are getting some of the resourcefulness and spirit of technological adventure that we need. In the last few weeks, for example, private engineering and technical concerns have come to the Public Health Service with new ideas for combining pollution control with mass solid-waste heat conversion. In one case, power would be generated. In another, water would be purified. Feasibility contracts with the firms are being considered.

The same spirit of initiative and innovation will be found in the nine Public Health Service grant-supported projects aimed at improving solid-waste incineration technology, and of course, environmental quality. Four of the projects recover and put to work some of the vast quantities of incinerator heat now all but completely wasted.

Innovators are also at work to improve the economics as well as the health and safety of waste collection and transportation, which, if wastes are manually collected, now absorb more than 70 percent of disposal costs. Two large railroads have ideas for mass transportation of solid wastes. At the same time, Public Health Service grant researchers are exploring the application of pipeline technology for rapid, large-volume solid waste transportation. Mass transportation is an absolute necessity in many parts of the country where sanitary landfilling is the best means for disposing of solid wastes away from urban areas and with minimum contamination.

The need is equally compelling for making maximum use of landfill capacity through reduction of waste volume. The makers of compacting equipment and motor transport, and other industries are making important contributions to meet these needs.

Some of our Public Health Service grant projects are working intensively on several approaches to landfill improvement. One is to demonstrate solid-waste volume reduction by as much as 90 percent during fill operations. In another, investigations are being made of water pollution hazards in operation landfills where previous rock formations are found.

Our grants to aid demonstrations of new and improved technology or studies of new approaches to solid-waste management are awarded only to those local and State agencies which have prohibited, or plan to prohibit, open dumping or open burning.

Prizes for national achievement in solid-waste management should not be awarded until all resources and technological ingenuity have been dedicated that are necessary to bring within sight the day when solid wastes are managed with irreducible pollution of land, air, and water.

". . . civil engineer . . . author of 'Environmental Sanitation' . . . thirty years experience in environmental health . . ."

DISCUSSION

THE THIRD DIMENSION: LAND POLLUTION

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The environmental health factors which have been given the most visibility in recent years are air and water. Although air and water are essential for survival, a third factor or dimension, namely land, is also necessary for survival on earth. If this dimension is not kept clean, not only will we be physically and psychologically buried by our own wastes, but also there will be established an environment which will favor return of the old filth-borne disease vectors.

Air pollution control standards limit or prohibit the discharge of certain pollutants into the atmosphere. The extent to which this control is effective will determine the amount of solid or liquid waste to be separately disposed of.

The control of industrial and commercial wastewater discharged into sewers usually means prohibition of certain wastes, or treatment to an acceptable level, before discharge to the sewer. In either case, a solid residue or liquid waste which may be toxic or otherwise hazardous usually remains to be disposed of in a manner which will be safe and which will not cause air, water, or land pollution.

The land therefore inherits not only the solid wastes of our urban society, but also the unwanted solid and liquid wastes resulting from water and air pollution control.

THE THIRD DIMENSION

It is being recognized that the third dimension, the land, must be protected from pollution by the urban, commercial, industrial, and agricultural solid wastes. The land is an ultimate depository for the unwanted solid wastes from our society. If uncontrolled accumulations are permitted, they remain to despoil the land for all to see.

In contrast to polluted air and water, which usually are not stationary and hence are acted upon by physical, chemical, and biological forces—sometimes favorably and sometimes unfavorably—solid waste, as all-too-commonly disposed of on the land, may be reduced in volume but it does not go away. It just stays where it is to haunt us day after day until the people forcibly insist that the disposal of solid wastes be properly managed. It is not, of course, always necessary to wait for a revolt or a crisis to force action, for at such times action may be motivated by emotion or expediency, rather than by reason of sound engineering and economics.

The increasing urbanization and growth of our suburbs have had a dual effect. On the one hand, population growth has increased industrialization, while packaging of food and manufactured products, has caused an increase in the volume of solid waste to be disposed of. On the other hand, the encroachment of housing on formerly isolated areas used for refuse disposal by open burning and by old incinerators has resulted in numerous complaints due to smoke, odor, rats, flies, and other vermin nuisances as well as, in many instances, water, air, and land pollution.

Local officials are being pressured by the people into doing something now to solve the problems. The officials in turn look to their health departments for technical assistance and guidance.

The spreading urbanization resulting from population increase, in some instances, is causing a scarcity of suitable land for refuse disposal located within an economical hauling distance of urban centers. But the selection of a suitable site is more often hampered by economic, sociological, and political factors, rather than by technical considerations, although these too need to be improved.

This emphasizes the need for imaginative, long-range planning and administration for solid waste collection, treatment, and disposal, on an intermunicipal basis.

PLANNING ADVANTAGES

County or regional areawide planning and its administration for solid-waste collection, treatment, and disposal can help overcome some of the seemingly insurmountable obstacles to satisfactory solution of the problem. Some of the advantages of county or regional areawide solid-waste management can be summarized as follows:

1. It makes possible comprehensive study of the total area generating the solid wastes, and consideration of areawide solution of common problems on short-term as well as long-term bases. This can also help overcome the mutual distrust that often hampers joint operations among adjoining municipalities.

2. There is usually no more objection to one large-site operation than to a single town, village, or city operation. Coordinated effort can therefore be directed to overcoming the objections to one site and operation, rather than to each of several town, village, and city sites.

3. The unit cost for the disposal of a large volume of solid waste is less. Duplication of engineering, overhead, equipment, labor, and supervision is eliminated. For example, the cost of refuse disposal by sanitary landfill for a community of 50,000 may be about $1.50 per capita. For a community of 450,000, the cost would probably be about $1.00 per capita. Incineration costs for the same example would be in the range of $4.50 per capita for the smaller to $3.25 for the larger community.

4. It can also be said that better operation is possible in an areawide service, as adequate funds for proper supervision, equipment, and maintenance can be more easily provided.

5. More sites can be considered. Some municipalities would have to resort to the more costly method of incineration simply because suitable landfill sites may not be available within the municipality.

6. County or regional financing for solid waste disposal often costs less, as a lower interest rate on bonds can usually be obtained because of the broader tax base.

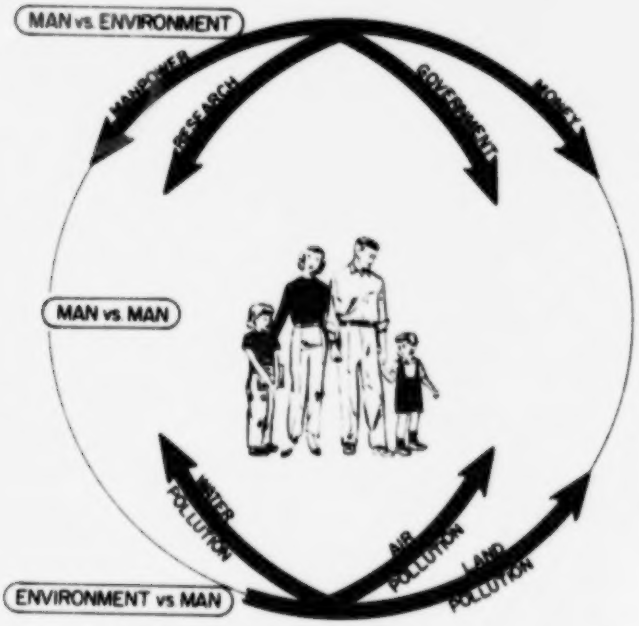
7. A county agency or a joint municipal survey committee, followed by a county or regional planning agency, and then an operating department or district, is a good overall approach, as it makes possible careful study of the problem and helps overcome interjurisdictional resistances.

PLANNING INCENTIVES

Solution of the solid waste problem should start with an inventory, study, and analysis of the facts relating to the immediate and future sources of all solid wastes. An overall general plan, which is within the context of the comprehensive community plan, is then prepared. This should include alternative solutions to the solid waste

SOLID WASTES

THE THIRD POLLUTANT IN THE THIRD DIMENSION



THE THREE ENVIRONMENTAL POLLUTIONS AND THEIR SOLUTION

problem and approximate costs, to enable the local officials to make a decision. Detailed engineering plans, studies, specifications, and construction would follow.

Incentives are available to encourage orderly planning leading to construction. Some of the better known are listed below:

1. The Department of Housing and Urban Development (HUD) 701 program for comprehensive community planning is available through their state planning agency to cities and other municipalities with less than 50,000 population, to counties without regard to population, and to Indian reservations. The Federal grant is for two-thirds of the cost of the work, local contribution is one-third in New York State, one-sixth State and one-sixth local. In some instances Federal grants may amount to as much as three-fourths.

2. More intensive planning of a community facility such as refuse disposal is also possible under the HUD 701 Program. Two examples are the 1963 Capital Region Planning Commission Study in Connecticut and the 1964 Refuse Disposal Plan for the Detroit Region.

This planning-type study can bring the solid waste problem into proper perspective with all aspects of community planning, including land use, transportation and circulation, urban renewal, and community institutions and facilities. Long-range fiscal plans and programing, and scheduling of capital improvements, are included. The study must be general in scope, consistent with the detail of other comprehensive elements. Engineering and cost elements would be based on approximate unit costs rather than on detailed calculation.

In New York, proposals submitted by the planning consultant under the HUD 701 Program are reviewed for completeness for indicated environmental health needs by agreement between the Office of Planning Coordination in the Executive Department and the Department of Health.

3. Under the HUD 702 Program, interest-free advances are available for detailed engineering studies and designs for feasible public works, including areawide and long-range projects. These would include incinerators and sanitary landfills. A refuse study recommending a central sanitary landfill was completed in Greene County, New York, in 1965. Long-term loans up to 40 years for the construction of public facilities may also be available.

4. The Solid Waste Disposal Act contains funds for municipalities to cover up to two-thirds of the cost for the demonstration of new and improved methods for solid waste disposal, for research and development, for training, and for matching grants to States to develop State programs.

5. In New York State, a 100-percent State aid program is available to encourage areawide planning for the collection, treatment, and disposal of refuse. This is discussed further below.

6. The last planning incentive is the Housing Act of 1965, which permits grants to a community not to exceed the interest charges on a loan incurred to finance the acquisition of land for a period not to exceed five years. This can make possible the advance acquisition of land for refuse disposal sites, but the applicant must start construction within the five year period.

ADDITIONAL ASSISTANCE NEEDED

The Solid Waste Disposal Act is an excellent logical start in attacking the solid waste problem. The Office of Solid Wastes has made an admirable start in this one-year period. However, more must be done to ensure solution of the problem. Federal and State financial assistance and incentive are also needed to encourage areawide planning, construction, and proper continuous operation of solid waste collection and disposal facilities. This will require adequate professional personnel and trained supervisory and operating manpower at the local level.

It is not too soon to consider a certification program for operators of incinerators, sanitary landfills, and solid waste treatment plants. An operation and maintenance grant program can help ensure that the large amount of funds spent for the construction of structures and the purchase of equipment are actually accomplishing the intended objectives, including air, land, and water pollution control.

The time has also come, before a new product or packaging is put on the market, that consideration be given to its ultimate disposal, as has already been pointed out. A protocol for its salvage, reuse, degradation, or destruction should accompany the introduction. Is not this a proper development cost?

New products and formulations are usually registered and, if toxic, certain precautions and methods of testing are required. The use of some highly toxic and persistent pesticides has been severely limited, or in some cases actually prohibited. Nonbiodegradable detergents are all but replaced by degradable types, a mixed blessing, perhaps. Although it was done under threat of regulation, it is to the credit of the detergent industry that this was done voluntarily.

By the same token, it is time for all industries and the government to recognize their responsibility. They should not wait for a solid waste crisis and perhaps hasty regulation, but should start now to help solve the solid waste problems to which they contribute.

STATE INITIATIVE

New York State has taken the initiative by adopting a 100-percent planning grant program to stimulate and encourage county and regional areawide planning for the collection, treatment, and disposal of solid wastes. Under enabling legislation in the Public Health Law, "It is the purpose of the State of New York to encourage the development of economical projects for the present and future collection, treatment and disposal of refuse in such a manner as will assure full consideration of all aspects of planning for proper and effective solid waste disposal coordinated so far as practicable with other related State, regional and local planning activities, and consistent with the protection of the public health, including such factors as population growth, urban and metropolitan development, land use planning, water pollution and air pollution control, and the feasibility of regional refuse disposal programs."

State aid for comprehensive areawide planning would cover 100 percent of the cost of study, meeting the requirements prescribed by the State Commissioner of Health. For the fiscal year 1966–67, $250,000 has already been set aside, and additional appropriations are authorized for the next nine years. The studies would be conducted on a contractual basis among the municipalities, a consulting engineer, and the State Department of Health. A study area would normally involve one or more counties and encompass the urban and metropolitan area so far as practicable, and provide for the disposal of present and future solid wastes from the area.

CONCLUSION

Planning for the disposal of solid wastes on an areawide basis must be integrated and coordinated with comprehensive community planning. And comprehensive community planning must be integrated and coordinated with environmental health and engineering planning, including planning for solid waste collection, treatment, and disposal.

However, this must be supplemented by proper design, construction, and operation of solid waste disposal facilities if the benefits are to be realized by the people. It is also emphasized that county or regional areawide operations can make economically feasible what is relatively expensive when done on an individual basis by the small or average city, village, or town.

For a while, I thought that the only way we were going to solve the solid waste problem on land was to convert it to a water or air pollution problem—where the research, manpower, money, and visibility are being directed. But I am now becoming hopeful that a reasonable environmental pollution control balance will be achieved, and that as the air and water "clear," all of us on the Federal, State, and local levels will also direct our energies with equal vigor to a clean land and thus obtain a healthful total environment for man.

". . . doctorate in botany and mycology . . . educator, researcher, environmental consultant . . ." (Golueke)
". . . engineer . . . directs research in all areas of environmental health sciences . . . professor at VPI and University of California . . ." (McGaughey)

FUTURE ALTERNATIVES TO INCINERATION AND THEIR AIR POLLUTION POTENTIAL*

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INTRODUCTION

If we rule out—on grounds of economics, resource conservation and other practical considerations—the possibility of permanently orbiting the currently unwanted residues of our life and civilization around the moon or some other heavenly body, we must reach the conclusion that "refuse" will always be with us in the air, in the water, or in the land. Obvious as this conclusion might seem to even the most unthinking human, or trite its repetition, little awareness of it is evident in our institutionalized efforts to manage solid wastes. Instead we have behaved as though it were the simple duty of our public servants to come up with some no-cost alternative any time citizens, for reasons of health, esthetics, or pure sentimentality, might disapprove of a burning or landfilling operation.

Although we have recently begun to recognize the interrelationship between our air, water, and land resources, as a nation we have not yet quite grasped the fact that into the air, into the water, or into the land, as gases, liquids, or solids, represents the entire gamut of refuse disposal possibilities. In reality, only the land and the oceans represent permanent "sinks" for waste products. The atmosphere has but limited reservoir capacity. It serves largely as a transport system to distribute its burden to land and water, or as a reactor in which that burden can be transformed into another product easier to deposit or more readily absorbed by the vast ocean surface.

If we concern ourselves primarily with air pollution, either engineered or inadvertent, there are only three phenomena which may be exploited—gasification, vaporization, and pulverization. All three of these we do simultaneously by incineration of refuse. And if we wish to prevent any individual gas, vapor, or particulate matter from going into the atmosphere from our incinerators, we must arrange suitable technology to shunt it directly off to the land or water. In considering the air pollution potential of solid waste disposal processes other than incineration, therefore, we need only to consider to what degree the process introduces gases, vapors, or particles into the atmosphere, either deliberately or incidentally; and whether the nature and amount of these fractions are cause for concern from our air pollution viewpoint. At the very outset one might expect that "flinging" refuse on the ground or into the water will be accompanied by far less air pollution than flinging it into the air. So profound is this truism that more reflective authors would surely have turned down the assignment described by the title of this paper. However, it is the conclusion of the authors that some good may result from documenting the fact that alternate methods of refuse disposal have been given consideration in relation to air pollution.

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*Paper delivered by Dr. Golueke.

A proper evaluation of any method as an alternative to incineration, however, is not based solely on that method's air pollution potential, particularly since it is almost certain to generate less air pollution than burning. It would rest heavily on a consideration of the method's practical and economic feasibility, range of applicability, reliability, and role in resource conservation. This is to say that it should be practically and economically competitive with incineration. However, in situations where air pollution is a prime consideration, considerable practical and economic value can be ascribed to the fact that the alternative method does not pollute the air.

On the foregoing rationale, we outline here the principal alternatives to incineration, explain briefly how they function, and evaluate their potential both as feasible processes and as air polluting procedures.

AIR POLLUTION POTENTIAL

There is, of course, no need to review here the whole concept of air pollution as a factor in man's environment, nor the rationale and numbers involved in "standards" for its control. However, it might be useful to call attention to the rationale assumed as the baseline for comparing alternate methods with incineration. Specifically, we are concerned with the relative ability of alternative solid waste disposal methods to produce those factors known to be injurious to the health of man, animals, and vegetation; or which diminish the clarity of the atmosphere to a degree unacceptable to man. We are also concerned as to whether air transport of one or more of its end products is an essential feature of the method. And, regardless of whether air pollutants are introduced deliberately or incidentally, the scale of the detrimental effect is important. In this context air pollution might be designated (to coin a term) as "macro-air-pollution" if the effects are areawide; or as "micro-air-pollution" if only the immediate environment of the site is affected.

Measured on this scale, incineration might be said to result in micro-pollution by the process of segregating combustibles from non-combustibles; and in macro-pollution by its burning, or high-temperature dry oxidation process. All alternative methods here discussed, with the possible exception of pyrolization, have a predominantly micro-pollution potential.

NATURE OF ALTERNATIVES

If we consider the whole mass of solid wastes of a community as a stream of residues, either mixed or unmixed, coming for disposal by a public agency, we are appalled at the magnitude and variety of material involved, and dismayed at the limited number of basic methods by which it can be sequestered on the earth without impeding man's freedom to make use of the resources from which it sprung.

The combination of household, commercial, industrial residues, and agricultural residues from a modern community now probably exceeds 6 pounds per person per day. It includes garbage, commercial paper and swill, demolition debris, animal manure, yard and tree trimmings, food processing residues, industrial wastes, junk and old automobiles, ashes, street sweepings, and miscellaneous rubbish. Some of this material is organic, some inert.

Without regard to the technological and economic factors, there are but a few possible alternatives for disposal either now or in the future:

1. Deposit the entire stream upon the land.
2. Deposit the entire stream in the ocean (coastal areas).
3. Split off selected fractions (e.g., rag, paper, metallic, glass) for return to the raw material resources of man, depositing the remainder on land (or in the ocean).
4. Split the stream as in (3); then further split off combustible organics for:
   (a) Discharge to the atmosphere by incineration, returning the residue to the land- or sea-bound fraction.

(b) Composting or anaerobic digestion for return to the land separate from the land- or sea-bound fraction.
(c) Wet oxidation to produce products useful as raw materials in industry.
(d) Pyrolization to produce useful raw materials and residues.

Thus landfill, ocean disposal, composting, wet oxidation, and pyrolization represent the major classes of alternatives to incineration; and, significantly, landfill is an important factor in all, including incineration, except ocean disposal.

These alternatives, it must be concluded, represent a somewhat pedestrian list. This has too often been misinterpreted as precluding imaginative and novel solutions to the solid wastes problem. There is great need for inventiveness and innovation in the way materials are handled in these processes, in utilizing the products, and above all, in reducing the volume of the stream at its source.

INCINERATION

Incineration is simply a dry oxidation process involving high temperature burning. Segregating combustible from noncombustible materials may result in dust and odors in the vicinity of the operation. The burning process, however, discharges particulate matter and oxides of nitrogen, sulfur, and carbon. If poorly operated it may produce a tremendous variety of polyunsaturated hydrocarbons, some of which are known to be carcinogenic to animals and man. Some 10 percent by weight of the original charge appears as ash, which must be disposed of on land.

The air-polluting potential of incineration can, of course, be minimized by efficient burning and by the use of precipitators to remove particulate matter. It is likewise suggested that other objectionable fractions of the stack emissions might be removed. However, somewhere between the poorest incinerator and the ideal one which discharges only carbon dioxide and water, the cost of trapping the products of combustion for direct return to land or water may become disadvantageous, particularly if wet oxidation can be developed to produce more commercially attractive byproducts.

SANITARY LANDFILL

The sanitary landfill method can hardly be described as a "future alternative"—it has long been a common practice. Nevertheless, it undoubtedly will be an important method for many decades to come since the ultimate sink for all solids rising from the earth, is the earth; all other methods of disposal (short of atomization or rocketry) are merely steps in preparing the solids now regarded as wastes, for consignment to the earth. However, in this part of our discussion, we consider it as a complete or primary disposal method, and not as a final step following some other intermediate process.

Since the mechanics of the method are so well known, we omit a description of the process and turn to a discussion of its air pollution potential, feasibility, etc. In a properly conducted landfill, in which no onsite burning is allowed, air pollution is limited to the vicinity of the disposal site. Dust, odors, and vapors arising in connection with the unloading and filling operation may represent important air-polluting factors. If we interpret air pollution very broadly to include the presence of undesirable fractions in the gaseous envelope of the earth, the gases of decomposition of filled material may be of concern. For example, methane released into houses or buildings overlying or adjacent to the landfill might lead to disastrous explosions.

Since anything, no matter how large or heavy, and whatever its nature, can be buried, all types of refuse can be disposed of by the sanitary landfill method. The economic feasibility of the sanitary landfill as a disposal method, however, currently depends upon the existence of reasonably priced available land relatively close to the waste-generating area. Herein lies the major difficulty in the future use of the landfill method, inasmuch as land meting these requirements is fast becoming a thing of the past. Under current conditions, hauls exceeding round trips of 40 miles are regarded as uneconomical (although there is good reason to believe that a well conceived transport system might in the future increase this figure manyfold).

Since new land sites are becoming increasingly difficult to find, it is important to develop methods for expanding the capacity of existing fills. An obvious method is to increase the weight-to-volume ratio (density) of the incoming material, such as by compaction and grinding. Another way would be to develop a method whereby a fill could be reused indefinitely. This could be done if, within a reasonable length of time, the decomposition of the buried refuse could be sufficiently stabilized to be exhumed without danger to the general public health or offensive to the senses of odor and sight. The excavated material, mixed with previous cover, could be used as cover for the new fill. Build-up would be minimal, since decomposition of the excavated organic material would continue until the ultimate breakdown of the organic phase to CO_2, H_2O, and minerals (ash) is achieved.

Such a possible solution, however, lies in the future. The problems are twofold: (1) To bring about the desired degree of stability, the anaerobic decomposition (the major phase occurring in a conventional landfill) would have to be followed by an aerobic phase, and no way of accomplishing this aeration without resorting to an operation akin to formal composting has yet been found. (2) Nutrients needed for rapid decomposition must be supplied. Technologically this latter problem can be easily solved, simply by determining the identity and the required dosage of the missing nutrients and then supplying them.

The economics are uncertain. Probably, nitrogen would be the element in short supply. If this should be the case, an application of $(NH_4)_2SO_4$ or any other inexpensive nitrogen source would serve the purpose.

A research group at West Virginia University is studying the nutritional aspects. Merz (U.S.C.) and the Los Angeles County Sanitary District are studying decomposition in test cells to determine the feasibility of excavating fills.

Strictly speaking, the resource reuse potential of the sanitary landfill method is negligible, since the refuse is buried and thus rather "permanently" removed from recirculation. However, in a broad sense (i.e., of reclamation) certain land sites may be made usable. Thus, the level of a tidal flat could be raised above high tide level; marshland could be converted to "dry" land, and quarries and canyons could be filled. The use of such reclaimed lands is generally restricted to recreation, not only because of the limited load-bearing capacity of the land, but also because of the presence of pockets of methane in the soil and of corrosive organic acids which would corrode unprotected utilities.

COMPOSTING

Composting, as applied to waste disposal, is the biological decomposition of the organic component or refuse under controlled conditions. In modern practice the process is conducted under aerobic, termophilic conditions. The operation itself consists of a number of steps. The first step is one of separation in which salable and noncompostable material is removed. In the succeeding steps, the material is ground, subjected to the composting process, screened, and usually ground a second time and windrowed ("curing" or "maturing" stage). The composting process may be done either in enclosed, mechanized structures ("digesters") or in the open in windrows. The advantage of the mechanized approach is that the environmental conditions for the decomposing material can be closely controlled, i.e., maintained at optimum levels, and hence the process can be accelerated somewhat. Major disadvantages are the high capital and operational costs.

The finished product is a stable organic residue, whose chief use is as a relatively low grade soil conditioner. The quality of the end product is a function of the particular method used in the composting step, of the raw material, and of the extent of decomposition which has taken place up to the time composting has been terminated. Naturally, the more extensive the culling out of undesirable materials, the more close the control, the higher the ratio of easily broken-down organic matter (garbage fraction) to material decomposed with difficulty, and the longer the "maturing" step, the better will be the end-product, i.e., with respect to agricultural applications. Volume reduction of the material entering the composting process ranges from 30 to 40 percent, depending upon the nature of the incoming material. The larger the proportion of "soft" organix (garbage) to "hard" organic matter, the greater will be the reduction in volume.

Since volume reduction is largely the result of the loss of moisture and conversion of organic matter to gaseous and liquid products, the loss is mainly to the atmosphere; and therefore its air-polluting potential is worthy of examination. In a well-operated aerobic process, CO_2 and water vapor are the principal products. Neither can be classed as a pollutant in outdoor air. In this case only the dust and odors of unprocessed refuse would be of a concern in air pollution and would not differ greatly from that associated with preparing refuse for incineration.

A poorly operated or unplanned anaerobic composting operation might be a local air polluting nuisance through release of foul odors of decomposition. The foul odors can arise as the result of negligence and/or of a deficiency in the applied composting method. Examples of the former are poor handling of incoming refuse, allowing refuse to accumulate before processing, and slovenly housekeeping. An example of a deficiency in the process would be one which would result in unplanned anaerobic decomposition. The first source is easily remedied by exercising care. The second source may be more difficult to eliminate since it may be due to a basic defect in the method being used. Thus, if a mechanical composter is used, the device may have an inefficient aerating mechanisms; or if the open or windrow method is employed, the operation may not be conducted in a manner to provide adequate aeration. Anaerobic conditions also accompany an excessive moisture content unless extremely effective measures are taken to ensure adequate aeration.

Foul odors in existing large scale operations sometimes emanate from unattended storage piles of the end-product. If the material is insufficiently stabilized before stockpiling, it will continue to decompose; and since no aeration is provided, it will decompose anaerobically—with the usual accompaniment of objectionable odors.

The applicability of composting as a refuse disposal method is limited to the biologically decomposable fraction of municipal solid wastes and to the greater part of agricultural wastes. Because of its preponderance of non-organic and of highly carbonaceous relatively stable organic matter, municipal refuse cannot be composted to a high quality end-product unless additives are supplied to compensate for the lack of nitrogenous, easily broken-down organic matter. Consequently, composting would be most suitable to those applications involving the treatment of regional wastes in which proper proportions of agricultural and municipal wastes can be supplied without incurring the added complication of transporting of one or the other of the ingredients to the disposal site.

The practical feasibility of composting has been well demonstrated in operations ranging from research to full scale, in that it has been repeatedly demonstrated that municipal refuse can be made to compost. The major area for improvement in this phase is that of developing more suitable equipment for materials handling. For example, a sufficiently durable, completely satisfactory grinder remains to be designed. Effective automated methods of sorting incoming refuse would be a distinct help.

The economic problem of composting is the great stumbling block to the widespread use of composting at the present time. The record in the United States has been rather dismal, as is well demonstrated by the list of operating compost plants and those which have closed, as presented in Table 1. Economics constituted the deciding factor in the failure of every one of the closed operations. The financial success of each was based to varying extents on the sale of the end-product. This dependence in most cases was made without a previous survey of the market for customers for the end-product.

Had a survey been made, it would have been obvious that large scale agriculture (the only class of consumer large enough to absorb the potentially huge production of compost) was not and will not be interested in the end-product in the foreseeable future.

Added to the failure to find a market for the end-product, were the unexpectedly high capital and labor costs. All too frequently, the original equipment designed for an operation proved too "fragile" for the task, and the estimate of manpower was usually about half that actually required. The last two factors bring the cost of composting to the level (or higher) of that of incineration, but with the accomplishment of a much smaller percentage reduction in volume of residue to be disposed of on land.

ANAEROBIC DIGESTION

The definition used for composting also is applicable to anaerobic digestion. In fact, anaerobic digestion may be classified as a form of composting; and it is mainly for ease of presentation that we treat it as a separate category in this paper. As with composting, the first step is one of separation, in which salvable and non-decomposable material are removed. The material is then ground and subjected to anaerobic digestion. The digestion process can be carried on either in a conventional digester (one designed for sewage sludge) or in an especially designed structure.

If the process follows a course similar to that of sewage sludge digestion, as it most likely would, the end-products would be gas, sludge, and a supernatant. The gas would consist mainly of methane (55 to 75 percent) and carbon dioxide (20 to 35 percent). The combustible gas could be burned to supply energy to the process. The sludge would be a stable organic residue whose chief use would be as a relatively low grade soil conditioner. The supernatant would be a liquid relatively rich in dissolved and colloidal organic matter in various stages of stability. The supernatant preferably would be recycled in the process, since it would constitute a source of pollution if discharged directly into a receiving body of water. Reduction in the volume of the material subjected to the process would depend upon the nature of

TABLE I.—*Operating compost plants and those which have closed*[1]

Location	Manufacturer	Process	Capacity tons per day	Began operation	Present status
Altoona, Pa.[2]	Altoona FAM, Inc.	Fairfield-Hardy	45	1951 1963	Operating.
Boulder, Colo.	Colorado Composting Co.	Rasping	100	1965	Do.
Largo, Fla.	Metropolitan Waste Conversion Corp.	Organixs	50	1963[3]	Do.
McKeesport, Pa.		Windrow	100	1956	Closed.
Norman, Okla.	International Disposal Corp.	Naturizer	35	1959	Closed 1964.
Phoenix, Ariz.	Arizona Biochemical Co.	Dano	[4] 300	1962	Closed 1965.
Sacramento, Calif.	Dano of America, Inc.	do	40	1957	Closed 1963.
San Fernando, Calif.	Salvage & Conversion Systems, Inc.	Naturizer	70	1963[5]	Closed 1964.
Springfield, Mass.	Springfield Organic Fertilizer Co.	Frazer-Eweson	20	1954[6]	Closed 1962.
Williamston, Mich.	City of Williamston	Riker	4	1955	Do.
Wilmington, Ohio	Good Riddance, Inc.	Windrow	20	1963	Closed 1964.

[1] Refuse Removal Journal, 9 (7):10, 1966.

[2] Handles only table food wastes.

[3] Date of initial operation unknown; plant rebuilt in 1963.

[4] According to European Dano practice, capacity is about 175 tons a day.

[5] Date of initial operation unknown; continuous operation began in July 1963.

[6] Partially burned in 1958; rebuilt in 1961.

the material and probably would be on a par with that obtained in composting 30 to 40 percent.

The contribution to air pollution by anaerobic digestion would be in the form of odors and dust arising during the preparatory steps, of odors released during the digestion process itself, and of combustion products of the burned gases. Odors and dust can be minimized by careful control. Gaseous combustion products would be principally CO_2 and traces of oxides of nitrogen and sulfur. The volume of the latter two pollutants could be reduced to practically nothing by scrubbing the gases of decomposition prior to burning them.

The comments on the applicability of composting as a refuse disposal method are equally suited to anaerobic digestion, and are not repeated here.

A definitive evaluation of the practical and economic feasibility of anaerobic digestion as a refuse disposal method requires more information than is now available. Although an appreciable amount of research has been done on the anaerobic digestion of the garbage fraction of refuse, the work was concerned more with the impact of the introduction of ground garbage on sewage treatment than with the utilization of digestion as a significant method of refuse disposal. To broaden the scope of the applicability of anaerobic digestion to refuse disposal, more information is needed concerning the breakdown of those constituents more resistant to decomposition than is garbage—cellulose for instance.

OCEAN DISPOSAL (BURIAL AT SEA)

A seemingly unlimited sink for refuse from coastal communities is the ocean. This fact has not escaped the notice of these communities, and ocean disposal has been tried at various times and places. Methods of refuse disposal in the ocean range from merely hauling the waste to some point at sea and dumping it, to subjecting the material to some treatment before dumping. The treatment receiving most attention at present consists of increasing the density of the wastes by compression to a point at which it will submerge and remain submerged.

Dumping at sea without pretreatment is merely another version of the objectionable open dump—a marine version—and that has not proved a satisfactory procedure. Usually a large portion of the wastes fail to submerge, and eventually are washed up on the adjacent shorelines, thus accomplishing a recycling of the used resource, but not quite in the manner intended by the conservation-minded! Added to the inherent objectionable characteristics of the method are the uncertainties arising from meteorological and human vagaries. (The human factor is manifiested in the forms of maritime strikes and "slow-downs.")

Handling refuse so that it is immediately and permanently submerged eliminates many of the objectionable features of marine open-dumping, just as the sanitary landfill method transforms land dumping to a hygienically and esthetically acceptable method of disposal. The basis of the method is increasing the density of the material by compression to a degree at which it will sink to the bottom of the ocean and remain there. The required density is about 66.5 lb./cu. ft.

The problem is finding means of applying the required pressure. Members of the engineering section of the Los Angeles County Sanitation Districts have done a considerable amount of research on this aspect. They explored methods of pressure application ranging from placing baled samples of refuse in pressure chambers to forcibly ejecting them into the ocean at various depths by way of a tube. In their surface tests, they placed the material to be tested in a pressure chamber filled with water, and then applied the necessary pressure. The use of a hydraulic pressure chamber facilitates applying the requisite pressure to the refuse samples. Other workers were able to bring the density of refuse to only about 55 lb./cu. ft., by squeezing in an open hydraulic press. The limiting factor for the latter was the fact that "juices" were extruded at higher pressures.

The Los Angeles group found that the required density could also be attained by pushing the baled refuse through a tube projecting 30 to 50 feet below the water surface. This method of pressurizing probably holds more promise from a practical and economic standpoint than would a surface or land operation, since it eliminates the need for complex and expensive pressure equipment.

The Los Angeles group found that all components of refuse did not respond equally well to pressurization. For example, household refuse was most readily compressed, whereas some difficulty was encountered in treating mixed refuse. As in almost every present treatment method, plastic toys constituted the biggest problem. For some reason, they refuse to remain compressed or submerged.

The major unknown in the pressurization method of disposal at sea, is the question of how long the treated material will remain submerged. There is the possibility that, with the passage of time, decomposition may take place with an accompanying formation of gas to such an extent that the bales would swell and break and thus allow the material to resurface. Also unknown is the long range influence of the submerged material on the ecology of its immediate marine locale. These constitute important subjects for future research.

Since the process is as yet in the research and development stage, it is too early to make positive statements concerning its economic feasibility. According to the Los Angeles group, as far as technique is concerned, the main task to make the process applicable for full scale use is materials-handling.

The air pollution potential of ocean disposal is again only that of odors and dust in the vicinity of transfer stations and loading docks, and hence not materially different from that which accompanies any alternative process.

WET OXIDATION

Disposal techniques falling under the classification "wet oxidation" include a wide variety of methods ranging from biological to physicochemical oxidation processes accomplished at pressures ranging from atmospheric (in biological processes) to 200–300 atmospheres (in physicochemical processes), and at temperatures from ambient to 300–400° C. In biological wet oxidation, the refuse to be processed is ground to a particle size, the optimum dimensions of which are yet to be determined, suspended in a liquid medium, and aerated. From this brief description, one may conclude, and rightly so, that biological wet oxidation is another form of composting—taking the latter term in its broader sense. However, for our purposes it is removed from the "Composting" category because it is carried as "wet-handling" process rather than as a "dry" process.

Its applicability would be limited to approximately the same materials as composting would be; namely, biologically decomposable organic matter having a C: N ratio not much higher than 30: 1.

In physicochemical processes, oxidation takes place under high pressures and at elevated temperatures. Decomposition of the wastes may range from a few relatively simple extractions for obtaining desired end products to "complete" breakdown to an inert residue, CO_2, and water. The extent of the breakdown is a function of duration of treatment, temperature, and pressure. Those reclaimed intermediate products for which a demand may not exist, are recycled in the system, i.e., used as "fuel" to supply the energy required for maintaining the operation.

The range of applicability of physicochemical wet oxidation processes is wider than that of the biological form since nitrogen is not a required element. It probably can be used successfully on any organic carbonaceous material.

As the descriptions indicate, the air pollution potential of wet oxidation methods is negligible. In the biological forms, the material being treated would of necessity have to be completely enclosed, and thus be subject to relatively complete control. Moreover, since the process would be completely aerobic, and since decomposition is not accompanied by objectionable odors, the decomposition itself would be free of odors.

In physicochemical wet oxidation processes, a considerable amount of volatilization of intermediate products takes place. However, these either are extracted as useful products or are further oxidized. In either case, they do not leave the system to subsequently become an ingredient in air pollution.

At present wet oxidation processes are in the research and development stage, inasmuch as intensive research has only recently been directed toward this possible means of solid waste treatment.

PYROLIZATION

Pyrolization could well be termed as "arrested incineration" in that the initial steps of the two processes are closely similar. Pyrolization could also be regarded as a form of fractional distillation. Volatile constituents are distilled off at the degree of separation dictated by the demand for a given product.

As a solid waste treatment process, pyrolization may be described as the chemical decomposition of carbonaceous wastes by the application of heat. As decomposition progresses, various constituents are distilled off, the sequence of which is determined by the respective temperatures of volatilization. Intermediate products may be withdrawn for the use as reclaimed materials or may be used in the process as contributing energy sources. If carried to completion, the end products are carbon (charcoal), H_2O, and CO_2. The charcoal may be burned to supply energy to the process. Nitrogen and sulfur oxides will also be present, if raw materials containing nitrogen and sulfur are used and no provision is made for "scrubbing-out" their oxides. Herein lies the air pollution potential of the process. Unless pyrolization is confined to paper, paper products, and dry wood, some provision must be made for removing nitrogenous and sulfur degradation products. Otherwise pyrolization would match incineration in its air pollution potential.

Pyrolization may be applied to almost any waste or combination of wastes having a combustible constituent. The efficiency of the process, of course, is a function of percentage of combustibles. In pilot scale operations (Lantz), wastes ranging from wood, animal manures, and paper to the discharged debris from a Proler operation, have been successfully processed. The latter material, i.e., debris from the Proler operation, consists of a conglomeration of finely ground metallic and non-metallic material remaining after the salvable ferrous metal has been reclaimed. Approximately 50 percent of the mixture is combustible. In a large scale Proler operation this residue may range to several truckloads per day in volume. In pilot plant tests, it was found that although the charcoal formed in pyrolizing the debris was of too poor a quality for general use, it could be burned and thus serve as an energy source for the pyrolization operation.

Pyrolization as a solid waste treatment process is as yet in the research and development stage. An interesting and fruitful research project concerned with the larger than laboratory scale production of useful materials from wastes using heat is presently in progress under the egis of the City of San Diego and the U.S. Public Health Service. In the conduct of the research, waste materials are subjected to heat and the distillation products are indentified in the order of their appearance. The effect of heat and pressure on type, amount, and order of appearance of the breakdown products is being determined. The group reports that gases are evolved in the order of CO_2, CO, H, and CH_4.

Pilot plant versions of the pyrolization process (Lantz convertors), have been operated by the Pan American Resources Corporation for more than a decade. However, the operations are sales- more than research-oriented, and consequently work with them has been of a qualitative rather than a quantitative nature. Although the entrepreneurs hope to find a market for their process in the general refuse disposal field, they are at present concentrating their efforts on various specialized industrial applications.

CONCLUSIONS

The alternatives to incineration are almost entirely limited to landfill, composting, anaerobic digestion, ocean disposal, wet oxidation, and pyrolization. All of these require essentially the same handling methods as are associated with preparing refuse for incineration. Dust, vapors, and odors may therefore be a local air pollution problem in the vicinity of the processing site. Offense to the esthetic senses rather than danger to the health of men and animals, or damage to vegetation, might be considered a micro-air pollution potential common to all methods. The alternative processes themselves, if properly operated, make little further contribution to air pollution. Even with poor management, their pollution potential is confined to odors, dust, and some vapors, with the possible exception of pyrolysis which could rival incineration if poorly managed.

An evaluation of alternatives to incineration as methods of refuse disposal rests lightly on their air pollution potential. A consideration in relation to this potential is extremely important, however, since it represents the first step in a concern for man's environment and may lead the way to a broader examination in that environmental context. Such an evaluation, although beyond the scope of this paper, should be based on at least three major considerations:

1. It is no longer valid to judge (evaluate) a given method according to the rather limited standards currently followed. At present, the economics of a process constitute the major concern; other factors such as health and esthetics are given only grudging attention. A realization of the direct bearing of man's environment upon his well being is beginning to emerge and the willingness to expend more effort and money in maintaining the integrity of the environment will follow.

2. Hitherto, the recipient of much lip service and little action is resource reuse. In the future, however, to quote the Waste Management and Control Report,[1] "It is manifestly impossible for the human species to continue present rates of population increase, present rates of increased per capita consumption of goods, and simultaneously maintain an environment in which waste products do not become ultimately totally inhibitory to life. Consideration must be given to methods for total recycling of all materials consumed and subsequently discharged."

3. Fundamentally only the land and ocean can be looked upon as ultimate sinks into which solid wastes can be discharged. At present, there is no method of disposal, except dumping at sea, that does not return a large fraction of solid wastes to the land. An important aspect of a future method will be the extent to which its application can reduce this ultimate burden to the land.

ACKNOWLEDGMENT

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[1] *Waste Management and Control.* Report to the Fed. Council for Science and Tech. by the Nat'l. Acad. Sci. -Nat'l. Res. Council, Washington, D.C. Pub. 1400, p. 89. 1966.

". . . more than 25 years in public health engineering . . . research, development, process engineering and design in solution of industrial water and waste problems . . ."

DISCUSSION

FUTURE ALTERNATIVES TO INCINERATION AND THEIR AIR POLLUTION POTENTIAL

ROY F. WESTON
President,
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The earlier papers have been so comprehensive that there is little I can say that has not been said before. Therefore, I will take advantage of this opportunity to look at the subject of solid waste disposal in a broad sense to see if such an approach will help establish the direction that must be taken to come up with satisfactory answers for the future.

As explained by Dr. McGaughey and Dr. Golueke, the ultimate sinks are the land and the oceans. They state that the oceans are available to only 30 percent of the population. That means that at least 70 percent of the population must be concerned with the problems of disposal of wastes on the land.

This country has so many resources and can mass-produce goods so cheaply that a throw-away and planned-obsolescence type of economy has been established. Therein, of course, lie many of our problems. As nearly as can be estimated, the American public currently discards half a million tons per day of solid material. This may not include such things as mine tailings and some special industrial wastes. This estimate does not include materials that will be removed from wastewaters by the proposed water pollution abatement program. If biological treatment is provided for the organic wastes that currently are being discharged into our streams, it will produce another 20,000 tons per day of solids as secondary treatment sludge.

Approximately half of the total amount of material being dumped is combustible. The part that is combustible is 10 to 25 percent ash. Thus, no matter what is oxidized by incineration or alternatives to incineration, there will be hundreds of thousands of tons per day that must be disposed of onto the land, into the sea, or by methods unknown at this time.

If new methods are not de[illegible]d, land will be utilized at the rate of 100,000 to 200,000 acre-feet per year for the current solid waste load. Significantly greater waste loads are predicted for the future. As a matter of fact, the time in which we live, which we so proudly call the atomic age or space age—may very well be known to future historians as the "Age of Dumps."

What does this have to do with air pollution? Land use for disposal provides additional severe pressures for alternative solutions. Today, many of our municipalities and industries are running out of land for solid waste disposal and are looking to incineration as a method for reducing nuisance and the bulk of their landfill material. They are looking to incineration because it is the next most economical alternative to landfill.

The very nature of our competitive economy requires the use of that alternative most economical for the individual community or industry. This approach is necessary no matter how it may be influenced by government regulation or government subsidy. Therefore, for the immediate future, I predict that there is going to be a substantial increase in incineration. This need not be bad because available technology leaves no good excuse for poorly designed incinerators or harmful air pollution from this process. Although incineration will alleviate our solid waste disposal problem, it does not eliminate the problem. Obviously the alternatives to incineration should be researched so that solutions can be tailored to each specific problem. The ultimate solutions must control waste disposal to the land as well as to the air.

Therefore, we should be conducting research aimed at finding alternative ways of handling those wastes that are putrescible and may create a nuisance unless they are incinerated or properly disposed of in landfill. Also, we should investigate the different alternatives that have been suggested by the speakers at this conference. Those that are most important in my opinion are: (1) control at the source; and (2) segregation, recovery and utilization.

Control at the source must include the selection of materials and designs to minimize the problem of disposal of packaging materials and other disposable items.

Segregation, recovery and utilization have significant potential for the future. We should be conducting comprehensive surveys so that we can determine the quantity and character of the materials which we are wasting and the problems they are creating. There appears to be little specific information available. Thus, we do not know precisely what can be done about our problems nor the priorities that should be established. Only if we have this type of research information can we pursue our problem intelligently and effectively. It is quite obvious that we must develop economical ways of segregating useful materials, of recovering them, and of utilizing them. Actually, it is distressing to me, as one who has spent much time in water pollution control activities, that potentially valuable materials such as secondary wastewater treatment biological sludges cannot be utilized. This material is organic in nature, contains about 5 to 6 percent nitrogen and contains a small amount of phosphorus. It is a good soil conditioner. The City of Chicago alone has some 900 tons per day of sewage-treatment sludge to be disposed of, approximately one-third of which is the biological type. Some biological treatment sludges are potential sources of cattle feed.

In the very near future, there will be individual industrial plants producing from 15 to 30 tons per day of biological treatment sludges. We should be able to find a way for this material to be profitably utilized. The 20,000 tons per day thus produced constitutes about a quarter of the total production of commercial fertilizer.

We must look at all the different alternatives that have been mentioned here because we must come up with the most economical solution for each local situation. Since local situations vary, this means we shall need a number of different types of solutions at our fingertips.

Of one thing I am sure. To control the pollution or restrictive occupancy of land and to control air pollution, we must control at the source. This may involve drastic changes in packaging materials and practices.

It has been suggested by others that we may submerge ourselves in piles of rubbish and garbage. I suggested that ours may be called the "Age of Dumps." In spite of current problems and trends, I am optimistic about the future. I am optimistic because of the courage of our democratic form of government and because of the ingenuity and nature of our economic system. We continue current practices because the social and economic impact of these practices, up to this time, has necessitated change in relatively few localities. Any government that has the courage to outlaw hard detergents, to control automobile exhaust and to establish water quality and ambient air standards has the courage to control unsound solid waste disposal practices. Any society that can create the affluent throwaway economy we now have and can cooperate with government to the extent we have experienced to date, in other areas, can cope with forseeable problems of solid waste disposal.

Although our progress will be slow and painful, our social and economic heritage will be the protector of our natural heritage. It all depends on the will of the people. They can have the quality of environment they desire.

DEPARTMENT OF
HEALTH, EDUCATION AND WELFARE
PUBLIC HEALTH SERVICE
DIVISION OF AIR POLLUTION
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QUESTIONS AND COMMENTS

ROSLYN BARBASH, M.D. (*Chairman, Special Committee on Air Pollution, New Jersey State Medical Society*): Solid waste has been utilized as fuel by the power-generating plants of large European cities, such as Paris, Rotterdam and Dusseldorf. The method serves two purposes: (1) disposal of waste for some useful end by a large system which can apply the most efficient particulate emission controls and can be handled in an industrial zone; and (2) substitution for high-sulfur coal, ordinarily used for power generation, of a fuel that will not contribute sulfur oxides to the atmosphere. Why, in the light of these obvious advantages, which have already been proved in cities and climatic zones equivalent to ours, is the method not utilized in this country?

NOEL: In Chicago we have used the solid waste in one of our plants to generate steam. We're averaging about 1.3 pounds of steam per pound of refuse burned. In our future plants we hope to do the same thing, not only because there is a good potential, as far as eliminating particulates from going into the atmosphere, by the use of waste heat boilers, but also because the revenue is very adequate. Our one plant, I believe, cleared $80,000 last year by the steam generated and sold. However, there is one drawback to this method. You have to find a proper location to dispose of the steam. This isn't always available.

MICHAELS: In fact, there are several other incinerators that utilize waste heat and many have been evaluated at the time of design to determine whether or not utilization is economically feasible. So the concept is not new and there are other factors, such as the cost of fuel in the United States as compared to the cost of fuel in Europe, which are important considerations in analyses of this type.

GILBERTSON: I recall from the incinerator conference held in New York last summer that 27 percent of the incinerators constructed in the last 15 years or so have waste-heat utilization in some way. Some of it is relatively small, primarily for plant purposes, and others are on a wider basis, as suggested by the previous speaker.

DR. GEORGE KUPCHICK (*Director of Environmental Health, American Public Health Association*): Is sufficient consideration being given to grinding or pulverization to improve the character, and markedly reduce the volume, of refuse as a pretreatment to landfill, compost, or incinerating operations, or before transportation to disposal sites?

MICHAELS: One brief answer would be that this is a very good possibility. To date, inadequate consideration has been given to it but I think some steps have been taken, leading to studies and actual demonstrations of this process as a practical preprocessing technique. More and more, we have to think of the technology here as being two or more unit processes which linked together to make a system. This would be one of the unit processes. In fact, I know that the City of New York is considering the use of a hogger or grinder to reduce the size of oversize burnable wastes such as furniture and demolition material. Buffalo, New York, is planning the same kind of thing.

DON McCLENAHAN (*President, Sanitation Systems, Inc., Hinsdale, Illinois*): What is Chicago projecting as its cost per ton for construction and operation of its new ultramodern incinerator?

NOEL: At present, we have a consultant making some estimates. Based on earlier estimates from two different producers of electrostatic precipitators, and considering the fact that we're going to use a type of spray chamber with electrostatic precipitators which will add about $600,000 to our total cost, we figure that the final cost of our plant will be somewhere around $6,000 to $7,000 a ton. We hope we may be able to do better than that when all the design figures are in.

MICHAELS: Any indication of operating costs?

NOEL: When we acquire more sophistication in running the plant, maybe the cost of operation won't be as high as it is now. In my opinion, the operating costs might come down a little. In our newest plant, with allowance for the income we derive from the salvage of metals and steam, we average about $3.97 per ton.

MICHAELS: Does this include plant amortization?

NOEL: Yes. I would like to make a last statement here because of the inquiry about incineration costs. When I gave that figure I didn't give the figure of our first plant, which is not a modern-designed incinerator. It's a rectangular multiple-cell furnace type. If it will relieve your mind any, the cost of operation for that particular plant is about $5.90 a ton, but I was not considering an old-design plant when I gave you the figure; I was giving one for our new Southwest plant, which I consider a plant of modern design. At Medill, we do not salvage metals and we do not generate steam.

EUGENE L. POLLOCK (*Editor, Refuse Removal Journal, New York City*): Can you cite a successful composting operation in the United States? Composting has been a commercial failure everywhere in the world.

GILBERTSON: Let's put it this way. Composting is not only technically feasible; it is also being practiced rather widely, particularly in Europe and the Middle East. There are a few successful operations in the United States. There are also quite a lot of failures. Failures are not due at all to the question of technical feasibility of the process. It's due to what I call a completely mistaken idea of the economics involved. I would like to refer here not only to the question of composting, but also to all of the related areas where recycling and utilization come into the picture. I believe we're heading for a new equation. This involves a different concept from that of the cheapest approach.

I'm not talking only about unit costs, but also about a broader question of what the ultimate value is in terms of disposal of the waste, and its effect on the environment. When you incorporate these factors into the equation, you obtain a new answer. If you refer now specifically to composting, you have to look at it from the standpoint that perhaps it makes more sense for a city to actually subsidize composting because of the long-range values, including utilization of the product. Or, if you move over to any other field, pyrolization, for example, you come into a reclamation operation, which the community may have to pay for, but which in the long run is of benefit.

STEAD: I would like to follow up on Mr. Gilbertson's point. Where we get held up is when we encounter the interface between the public and private sectors. In the case of municipal refuse, this is now a liability and is so thought of, and yet no city run by elected officials can make a long-term guarantee that it will even give away its solid waste, let alone carry out a subsidized contract for, let's say, 25 years. The reciprocal of this exists when we get into the question of agricultural wastes. I'm speaking not only of animal manures (it's true there) but also of the field crop wastes that remain on the field. Out in our neck of the woods a large amount of it is burned, representing the sole exemption from air pollution control laws. Here we have a resource, if we can use this term, in the possession of the private sector. A farmer is far too canny to sell his animal manures, let alone give them away, if he has any suspicion that he is being "had" in the long run. Our sheer inability to cross this boundary freely and put the true fiscal and economic factors into Mr. Gilbertson's equation is one of our bariers.

NOEL: I would like to say something on a subject that apparently hasn't been touched, i.e., the residue from a well-designed incinerator plant. It has a multiple of uses. We have used it in Chicago mixed with lime for roadbeds. I've used it as a backfill for sewers without one bit of settling. Also it makes an excellent fill. Of course, it has to be conditioned a little by the removal of metals, and we do this in Chicago. We remove all the ferrous metals and sell them to a private contractor. Residue can be utilized—among other things, for the making of concrete block. In my opinion, the use of the residue from a well-burned-out vitreous clinker has not been researched sufficiently and there would be a number of ways in which it can be used to advantage. Of course, in some plants, in our Southwest Plant for instance, the organic material in the ash is down below 1 percent, giving the residue more use potential.

EDGAR L. HOAG, Jr. (*General Waterworks Corporation, Philadelphia*): Why is there no recognition of investor-owned-and-operated incinerators capable of serving several communities?

MICHAELS: Could you explain a little better what you're driving at, Mr. Hoag?

HOAG: Thank you for giving me an opportunity to explain my question a little bit. I've talked with Mr. Gilbertson and several other people who are here, about the question of investor-owned incinerators. I'm getting a little tired—and I think a lot of the rest of us are—of these figures that have been presented from Chicago, of $4.50 per ton. I think my colleague who spoke last is a little more accurate in his $6 figure, when all the costs are considered. All the discussion I've heard here today has revolved around government control in some way, or government investment or government grant for the solving of this problem, which I think the public has now been pretty well conditioned to accept as a necessity. I would like to hear some discussion of investor-owned incinerators operated in the manner of a utility at a specified cost per ton. Such incinerators could be centrally located in the so-called bedroom communities that cannot themselves afford an incinerator, but collectively could guarantee to an entrepreneur sufficient volume to justify an economical incinerator.

NOEL: We happen to have three privately-owned incinerators around the periphery of Chicago, and at the present time, Chicago delivers around 500 tons a day to these three incinerators. I'm not quite sure of the exact cost, but I believe the highest price paid per ton right now to a private incinerator is about $4.08. I am sure that this $4.08 includes a profit on the operation. So it's my feeling that any incinerator, if properly run, can operate for $4 or $4.50 a ton. These private incinerators must be doing it in Chicago or else they would charge us more than $4.08 a ton.

MICHAELS: Let's make a statement relative to the general question of private operation. Certainly there's no reason why private incinerators can't be built or communities can't bring their trash to them. It's strictly a matter of economics. The standards that a governmental plant must meet would prevail for privately-constructed plants, too. If private enterprise can compete with government, there should be no objection to this kind of approach. As a matter of fact, I think many communities would welcome the opportunity of being relieved of the responsibility of financing, building, and operating a disposal site. There are one or two plants in Florida that are privately built and operated to serve a community under long-term contract.

HOAG: I might add that one of the plants you referred to in Florida is now owned by a bank, simply because its owners underbid on the cost of operation. In connection with Mr. Noel's statement that the cost was only $4.08 a ton, I wonder what air pollution standards and what standards of combustion are required of those privately-owned incinerators. Are they in truth incinerators or are they merely vessels in which trash is burned?

NOEL: The plant at Stickney, Illinois, is a rotary-kiln type built by International Incinerator Corporation and I assure you it has good air pollution controls. The incinerator at Melrose Park has a wet-scrubber chamber. It also has a modified Schneible unit for removal of soot and particulates. Both plants separate their metals from the residue and sell them. One generates steam. So you can be assured that these plants are operated at a level at which we would want all incinerator plants to be operated. One of the problems, of course, is that neither industry nor government likes to see another agency make a profit, even from their wastes.

HAROLD MARTIN (*Bergen County, New Jersey Board of Freeholders*): Can you (Mr. Gilbertson) elaborate on the point you made regarding developments in a landfill process which led to a 90-percent reduction of waste materials? Also, can you cite instances of compaction and rail transportation of waste; what distances and what costs?

GILBERTSON: Briefly, the land-compaction approach involves a pre-processing technique in order to get a much denser composition of material before it is actually deposited in the fill. It is then covered with earth to maintain the compaction and density. As for rail transport, I think this is in the exploratory stage right now, but basically, the idea here is to use existing rail facilities, perhaps even existing rolling stock, for transportation of wastes out of the urban centers to more distant points, where they might be either processed or used for filling operations. There are a lot of other factors involved here, of course, even perhaps including interstate rail rates. But at this stage, I think we can say that some of the public agencies and some of the railroads are interested and are doing some figuring on it. Certainly, this has promise.

FRANCIS J. SMITH (*Bioenvironmental Engineer, Tactical Air Command, Langley Air Force Base*): What is the Federal Government doing to require that disposability be a consideration in packaging methods and materials for products sold to or made for Federal agencies?

GILBERTSON: We have had under consideration with various agencies, particularly with the Department of Commerce, the possibility of establishing some sort of criteria or standards which might be used in specifications for purchase of products. These would involve what the disposal problem might be. I think it's a little too early yet to say that these have resulted in any kind of conclusive approach, but I can state that this is not being forgotten. I would think that Federal procurement might be a logical place to start.

J. M. LEDNUM (*Engineer, Sayville, New York*): What is the basis for 5 to 6 pounds of waste per person a day? This figure appears higher than my experience on Long Island would indicate.

GILBERTSON: There has, of course, been a variation in figures in this area for many years, one which many people have been struggling with. We have been working diligently to see if we can come up with two things: (1) a fairly quick answer on what the picture is; and (2) a system which will result in a national data collection arrangement or system. The national data system will eventually satisfy the needs over a long period of time, but it will take something like 18 months to produce trustworthy figures. In the meantime, we have gone ahead with a variety of arrangements to try to pull together some figures that can be used in the interim to estimate the size of the problem and to guide our approaches. The figures referred to have been derived from sources which we consider useful, though not as accurate as a real data system would provide. They are on the high side, as I pointed out.

LEDNUM: In our studies on Long Island, we got about 4 pounds of refuse per person per day, about 1,500 pounds per year per person. Another comment I have is on the cost of incineration. The gentleman here just said it costs about $4 per ton for the incinerator. I find that it costs $9 per ton to collect your waste and $6 per ton to incinerate it, including the indirect as well as the direct costs. An incinerator will cost from $5000 to $8000 per ton, and naturally, this figure is based on the tonnage of the incinerator, not on the tonnage of collection because you run only about five-sevenths of the time at the incinerator's full capacity. So if your figures include collection, I think you'll get up to about $15 per ton.

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December 13, 1966

PANEL D

SOLID WASTE DISPOSAL

SECOND SESSION

Chairman Irving K. Fox
Professor of Regional Planning
University of Wisconsin
Madison, Wisconsin

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". . . directed water resources program, vice president, Resources for the Future . . . long-time government official. . ."

INTRODUCTORY STATEMENT

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The ideal situation would be to have a crystal-clear atmosphere, an atmosphere in which we had no contaminants. The suggestion was made that the most promising way to reach this ideal situation would be control of solid wastes at the source and segregation and reutilization of wastes that are produced.

There is a problem, however, in achieving the ideal. This is the problem of costs. And it is cost that we are concerned with today.

Costs, we find, are of two major kinds. There are the easily measurable costs of providing waste disposal facilities. More difficult to measure are the costs engendered by the contaminants resulting from alternative methods of disposing of solid waste—the contaminants to the atmosphere and to the countryside. For example, incineration and its byproducts may impose costs upon the population through polluting the atmosphere and these may be quite difficult to determine.

Because costs are widely dispersed and because the marketplace does not function satisfactorily in waste disposal, government has intervened. Government officials aim to take account of all costs including the burden of providing waste disposal facilities and the side-effects imposed on the population. Since air pollution control is one of the side-effects that can result from solid waste disposal, government is concerned with solid wastes in designing air pollution control policies and programs.

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CONTROL OF AIR POLLUTION FROM MUNICIPAL INCINERATORS

INTRODUCTION

Municipal incinerators have been in existence since about 1870 and therefore have a long background related to the subject of air pollution. Some of this background, particularly in the early days, is not too pleasant to remember, as the earliest plants did not recognize the air pollution potential which they created. Happily, the picture can be vastly different today, and it is still true that the contribution to air pollution made by municipal incinerators is a small part of the typical city's total problem. Of the 8,445 total tons of pollutants (including particulates, SO_2, NO_x, hydrocarbons and CO) which are emitted into the atmosphere of New York City on an average space-heating day, only 53.6 tons are said to originate in the city's 11 municipal incinerators.[1] The particulate matter included in the above figure is estimated at 225 tons from all sources, of which 35.5 tons originated within these same 11 municipal plants. It is therefore obvious that a significant contribution to air pollution control as a whole can be made in the reduction of particulate emissions from municipal incinerators.

DEVELOPMENT OF INCINERATOR AIR POLLUTION CONTROL PRACTICE

As previously indicated, particulate matter constitutes the major source of incinerator air pollutants. Other constituents such as sulfur oxides, oxides of nitrogen, hydrocarbons, and carbon monoxide are also emitted but are in such small amounts with respect to the usual cities' overall totals that their effect can be considered negligible. Until the end of World War II, relatively little attention had been paid by designers to the problem of reduction of particulate emission from incinerator stacks. Prior to that time, plants were at best equipped with subsidence chambers, which in some cases had baffle walls. The intent of these devices was to drop the velocity of the flue gas to a point where the larger pieces of particulate matter would settle out of the flue gas stream by gravity. Baffle walls were often constructed of brick checkerwork, and were intended to provide glowing impingement surfaces to facilitate burning particulate matter and also to entrap it.

Most, if not all, of the plants of that era were of the batch-fed type, wherein refuse

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was dropped onto the firebed from above, one charge at a time. Batch charges comprised several cubic yards of material, often in a relatively wet condition. The stack discharge was occasionally visibly smoky, due to the blanketing of the fire caused by the input of the new refuse batch. Also, this method of introduction of the refuse severely agitated the firebed, and generated large quantities of suspended particulate matter. Perhaps more important, this method of feeding caused introduction of large quantities of outside air into the furnace each time the charging gate was opened. This tended to lower the temperature of the entire furnace, and limited the ability of the system to burn out and deodorize all of the volatile combustion products. Residue discharge from this type of furnace was also on a batch basis from a collecting hopper equipped with a gate. The opening of this gate destroyed the furnace seal again, and admitted large quantities of outside air to the breeching between the combustion chamber and the stack. This caused the furnace to lose its combustion air supply due to the loss of furnace draft while the discharge gate was open, and again was a source of interruption to the combustion process. In effect then, while the batch feed process involved a minimum cost for equipment, it did provide a high air pollution potential.

Perhaps the fundamental reason for the lack of development of incinerator air pollution control practice was the fact that city codes in earlier days were of a nuisance elimination type. These were the "smoke abatement" laws which usually defined limits in terms of stack gas opacity. This was measured by means of the well-known Ringelmann chart which relies to a great degree on human judgment. Also, public knowledge and attitude regarding tolerance for stack emissions was vastly different than it is today, and budgets established for air pollution control allowed for very little actual enforcement of the law.

It is surprising, then, that even with the situation which existed, any development in the art of incinerator fly ash control took place. As previously mentioned, efforts were made in the form of subsidence chambers, some with checker walls and some without. A further development, initiated just after World War II, was the use of wetted baffles and subsidence chambers equipped with sprays. The intention was to cause suspended particulates to collide with water, either in drop form in an open chamber, or in sheet form as flow took place down a vertical baffle, and thus be trapped and carried to a "wet bottom" existing in the floor of the spray chamber. Some of these early designs consisted of dry baffles causing a U-shaped flue-gas flow over a wet bottom, with the intention that centrifugal action would cause the suspended matter to travel across the flue-gas flow at the bottom of the U and be entrapped when it contacted the water surface below. Many variations of these systems were tried, some of which will be mentioned in more detail later.

SPRAY CHAMBER DEVELOPMENT

As more experience became available, it was evident that the most effective spray chambers were those with continuously wetted baffles. Some baffle forms operate more effectively than others, but the more effective baffles from the standpoint of fly ash removal are those involving more tortuous gas passages and therefore larger pressure drops. A fundamental requirement of any fly ash removal system for a batch-fed incinerator is fly ash removal to meet applicable criteria with the simplest possible mechanical installation. This means that an air pollution control device which does not require the use of an induced-draft fan is most desirable. Sprayed baffle systems are in this category, and must be designed so that flue gas pressure drop does not exceed values somewhat lower than ½-in. w.c. to be acceptable under these conditions. Furnace draft can be maintained with two-stage baffle systems without the use of mechanical draft equipment, but the maintenance of this situation with more than two-stage baffles would be questionable. Figures 1, 2, and 3 show a two-stage baffle system of refractory construction which has had considerable success in our practice. The chamber in which the baffles

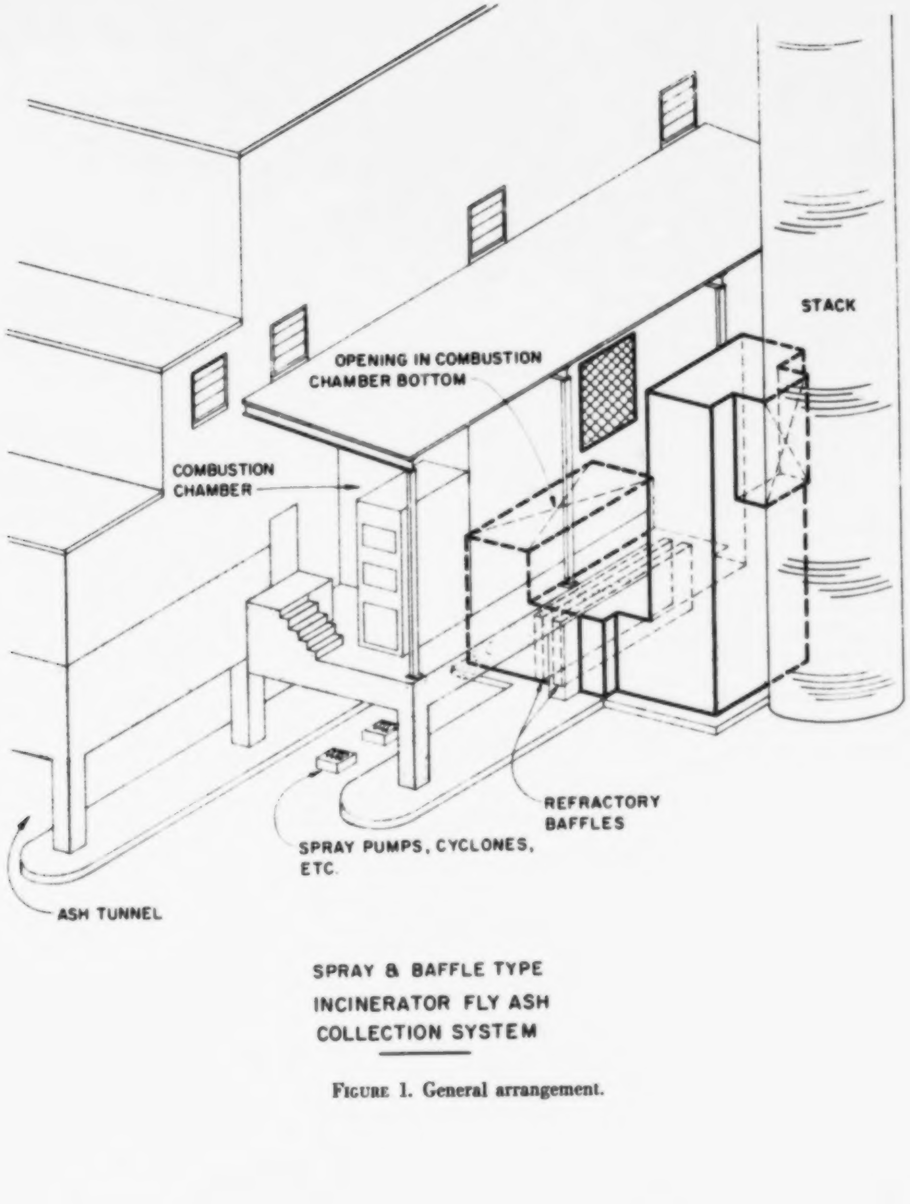
STACK
OPENING IN COMBUSTION CHAMBER BOTTOM
COMBUSTION CHAMBER
REFRACTORY BAFFLES
SPRAY PUMPS, CYCLONES, ETC.
ASH TUNNEL
SPRAY & BAFFLE TYPE
INCINERATOR FLY ASH
COLLECTION SYSTEM

Figure 1. General arrangement.

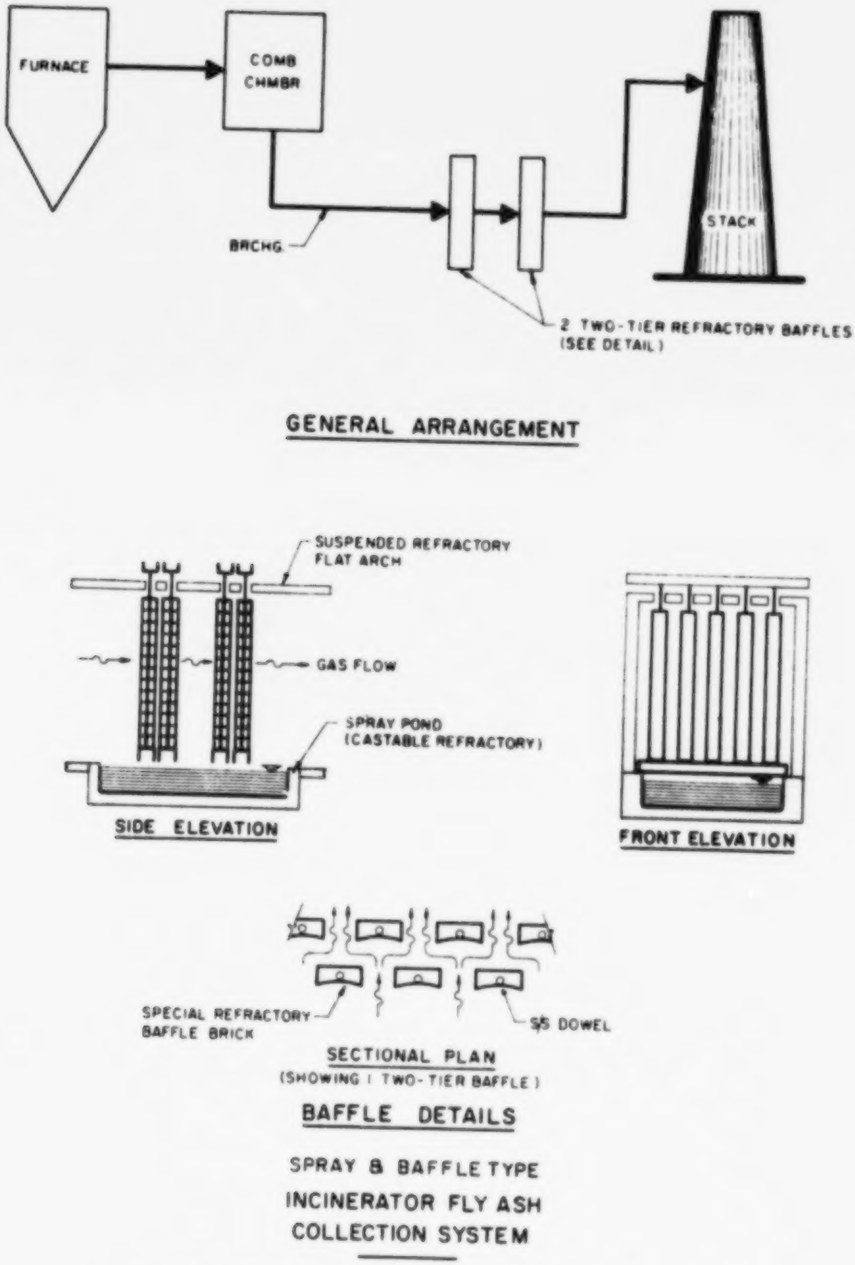
FURNACE
COMB
CHMBR
BRCHG.
STACK
2 TWO-TIER REFRACTORY BAFFLES
(SEE DETAIL)
GENERAL ARRANGEMENT
SUSPENDED REFRACTORY
FLAT ARCH
GAS FLOW
SPRAY POND
(CASTABLE REFRACTORY)
SIDE ELEVATION
FRONT ELEVATION
SPECIAL REFRACTORY
BAFFLE BRICK
SS DOWEL
SECTIONAL PLAN
(SHOWING 1 TWO-TIER BAFFLE)
BAFFLE DETAILS
SPRAY & BAFFLE TYPE
INCINERATOR FLY ASH
COLLECTION SYSTEM

FIGURE 2. Typical flue gas flow diagram and refractory baffle details.

are installed is normally designed for a baffle slot velocity not to exceed 3,000 fpm. (feet per minute). The corresponding pressure drop of the entire system is then between 0.3 and 0.4 in w.c.

More than one type of baffle has been successfully used in systems of this type. These include solid plate stainless-steel baffles which are subject to warping if allowed to run dry by error at any time. Another type is vertical steel plate baffle arranged somewhat like a Venetian blind with staggered rows similar to the refractory baffle shown on the figure. A new type of baffle, now in use at the Milwaukee, Wisconsin plant is of the Detrick-Jens type, which has been previously covered in the literature.[2] This baffle is of conventional mild steel construction and is generally similar in configuration to the vertical steel plate "Venetian blind" type baffle previously described. The difference, however, is that each baffle takes the form of a tall narrow water tank. Instead of water being sprayed on the outer baffle surface, water is delivered by drop pipe to a point several inches above the bottom of the inside of the tank. When the tank has been filled and as water continues to be delivered, an overflow takes place in such a way as to continuously wet the exposed face of the baffle. These baffles are reported to be almost entirely maintenance-free and to do an excellent job within the scope of this type of fly ash collection system.

As previously indicated, the efficiency of sprayed baffle systems varies with the number of baffle stages, and with details of the individual baffle construction of each type. Related to this, however, is the factor of pressure drop. In order for this type of baffle to be compatible with the natural-draft, batch-fed plant, its pressure drop must be kept within the limits previously given. Under these conditions these baffles are capable of meeting a criterion of 0.85 lb. of particulates per thousand pounds of flue gas, corrected to 50 percent excess air. It is not felt that such baffles will be suitable for meeting more stringent criteria than this.

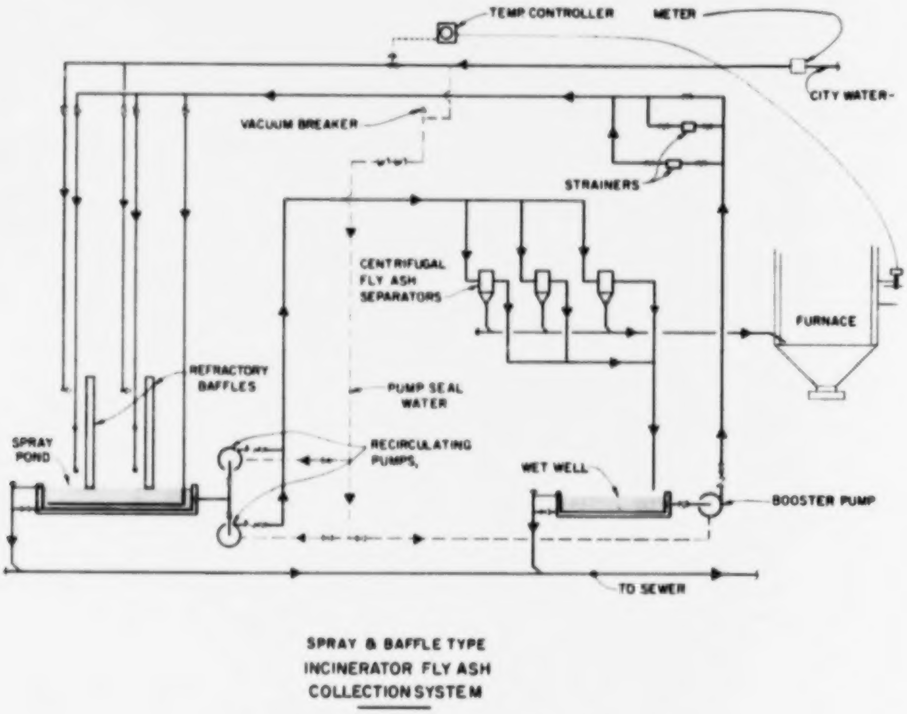
TEMP CONTROLLER
METER
CITY WATER
VACUUM BREAKER
STRAINERS
CENTRIFUGAL FLY ASH SEPARATORS
FURNACE
REFRACTORY BAFFLES
PUMP SEAL WATER
SPRAY POND
RECIRCULATING PUMPS,
WET WELL
BOOSTER PUMP
TO SEWER
SPRAY & BAFFLE TYPE
INCINERATOR FLY ASH
COLLECTION SYSTEM

FIGURE 3. Typical spray water flow diagram.

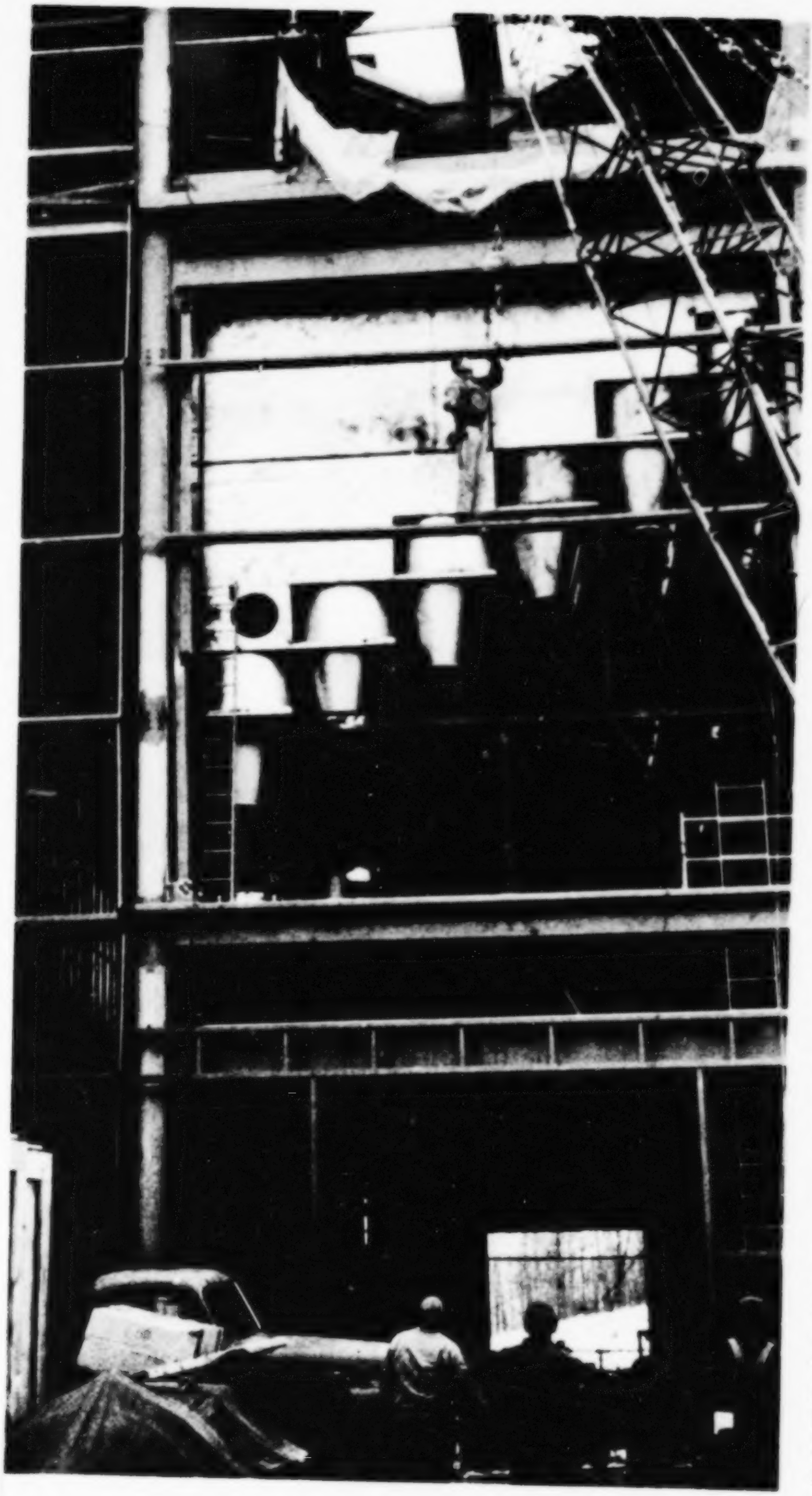

FIGURE 4

Concerning water consumption for sprayed baffle systems, the evaporation loss is normally about one-half gpm. per ton per day of actual burning rate. This corresponds to one gallon of water for each 2.78 lb. of refuse burned, or 720 gallons of water per ton of refuse burned. This quantity is the actual quantity of water evaporated, based on a leaving flue gas temperature of approximately 600 F. While there is no technical requirement which says that this much water must be supplied for effective fly ash separation, it is a quantity which has been found to be effective for this purpose. Most of the water is lost by evaporation but some is conveyed with the wet fly ash to its point of disposal.

Most previous designs have found it desirable to supply water at approximately twice this rate to ensure adequate contact between the particles in the flue gas and the water droplets, in order to provide effective fly-ash removal. When this is done, that portion of the water supplied which is not evaporated has sometimes been recycled. If recycling is through nozzles or perforated pipe headers, it is necessary to separate larger fly-ash constituents from the recirculated water. It has been found that where cyclones are used in this service the abrasive wear is such as to cause a need for parts replacement in periods varying from six months to two years, depending on the actual severity of the application in each case. Where this may not be acceptable, it may be more desirable to spend additional first cost dollars to construct a settling tank to accomplish this function.

MECHANICAL CYCLONE COLLECTION SYSTEMS

Where local criteria require a concentration of particulates lower than can be obtained with sprays and baffles, a mechanical multicyclone fly ash collector may be used. Figure 4 shows a unit of this type which was installed during construction of a recently completed plant. This type of collector involves a gas pressure drop in the order of 3½ in. w.c., and therefore immediately indicates a requirement for an induced-draft fan. Neither this fan nor the collector is suitable for continuous operation at temperatures much above 600 F. and therefore some type of gas cooling system must be installed ahead of the fly ash collector. This may be done by cooling with a combination of air and water, cooling with water only, or by direct heat exchange, as in a boiler. As might be suspected, the economics of operation is greatly affected by the method of gas cooling chosen. Were all-air cooling decided upon, it would be found that the resulting flue gas volume at the final temperature would be much greater than would be the case if all-water or direct boiler cooling were used. Some very interesting studies have recently been completed relative to this last-mentioned method of cooling. We have concluded that for certain types of high efficiency dust collectors, direct heat exchange cooling in a boiler may be economically feasible based on the reduced flue gas volume and the resulting savings for the induced-draft fan and dust collector. The general arrangement of a plant equipped with a water-cooled furnace is shown in Figure 5. These equipment cost savings combine with lower costs for induced-draft fan power corresponding to the smaller flue gas volumes being handled.

A recent paper [3] investigated the costs of various methods of air pollution control, including the effects of alternate types of gas cooling systems. In this paper, the authors report gas volume variation as given in the following table based on a single 250 ton per day furnace application:

Percent water/ percent air	*Gas volume (acfm)*
100/0	157,500
80/20	175,000
60/40	194,000
40/60	233,200
Water-cooled furnace (direct cooling)	74,200

As can be seen, differences such as these, all resulting from alternate methods of gas cooling for the same initial gas quantity leaving the furnace, result in tremendous differences in the economics of the air pollution control system and the mechanical draft system, in terms of both first and operating costs. These are things which should be investigated as part of any plant design involving gas cooling and dust collector engineering.

The multicyclone dust collector has a performance characteristic which should be understood in making an application. This

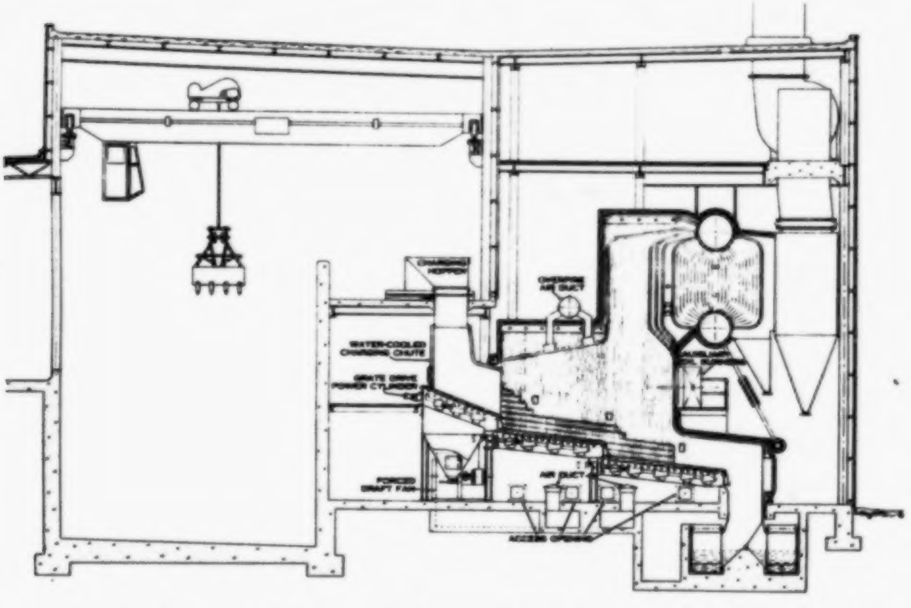

Figure 5. Two furnaces, each 180 tons of refuse per day capacity. Designed for maximum waste heat recovery. Construction completed 1966.

type of collector is extremely efficient on large particles, say greater than 30 microns in size, but has a much lower efficiency as particle size and mass become smaller. Where the expected particle size consist of the fly ash to be collected has an appreciable portion below 10 microns, a significant loss in efficiency is going to result, perhaps to the point where the required criterion cannot be met. Where refuse characteristics, higher under-fire air quantities, or methods of stoking are expected to generate abnormal amounts of fly ash, application of this type of fly-ash collector should be considered very carefully. Also, in the larger plants, and where flue gas cooling systems do not produce minimum gas volumes delivered to the collector, a comparison with an alternate lower pressure drop type of system might well be made. Such a comparison was made[3] for a hypothetical 500-ton-per-day municipal plant consisting of two 250-ton-per-day furnace units. In this illustration it was found that the economics actually favored installation of an electrostatic precipitator rather than a mechanical cyclone dust collector, and that this precipitator would produce a much cleaner stack effluent at less money spent per ton of refuse burned. It is recognized that the economics of this hypothetical case may not be typical for all actual cases which might be investigated, but the comparison did use typical values for water and power cost of 30 cents per thousand gallons of water, and 2 cents per kwh. of power.

BAG FILTER DUST COLLECTORS

This type of collector has not yet been applied to a full-size plant. It is not selective in performance but collects particles of all sizes within its selected operating range with equal efficiency. It does have a relatively high pressure drop, in the order of 5.0 in w.c., which makes its operating cost from induced-draft fan power consumption high. Bag replacement costs must be added to the cost of power. Such replacement is estimated to be required about once every two years. Bags would normally be made of fiberglass cloth or its equivalent, and are therefore relatively expensive. Although durable, bags of this material should not be exposed to more than 450 F. and a flue gas cooling system is therefore required.

Where very high efficiency dust collection is required for stack emission in the order of 0.035 lb. of particulates per thousand pounds of flue gas at 50 percent excess air or less, the bag filter is a possible selection which should be evaluated.

WET SCRUBBER SYSTEMS

Operating in the area of 6.0 in. w.c. pressure drop, and having a high particulate removal efficiency the wet scrubber has been used in a few municipal incinerator applications. It has the advantage of relative compactness and relatively low first cost when compared with either electrostatic precipitators or bag filters. In normal operation, the wet scrubber depends on an extremely thorough intermixing between the water and flue gas, and it is this thorough agitation which creates the relatively high pressure drop characteristic of this equipment. In order to meet the high particulate removal efficiencies indicated, the equipment normally produces a leaving flue gas which is saturated at the wet bulb temperature of the recirculating water, and the specific humidity of the stack effluent is therefore relatively high. A characteristic, then, of the wet scrubber installation is an almost continuous vapor plume at the top of the stack. While this plume is not an air pollutant per se, it has every appearance of being one, and may cause comment from property owners or passers-by in the neighborhood of the plant. Perhaps in some areas such a plume would not be acceptable. Water circulation rates required in scrubbers are high, and this may introduce a disposal problem. If recirculation of the scrubber water is practiced the water must be suitably prepared for use in the sprays. Spray water pumps are required to produce the pressures needed and may also be required for the makeup water supply as well as for the recirculating supply. The power requirement for these pumps, plus that required for the induced-draft fans, is significant and should be considered in any evaluation.

Within recirculation of water, chemical treatment may be indicated. Even with such treatment, scrubber maintenance problems may be affected by the absorption of gaseous products of combustion by the spray water, forming acids. Unless materials of construction are carefully selected, replacement costs may be high, both for the scrubber and for induced-draft fans and other downstream equipment. The most important consideration is the protection of all this material from excessive temperatures and excessive temperature changes. It should be noted that scrubbers are among the higher efficiency dust collection devices, that they are nonselective as to the particle size collected, and that they are capable of removing gaseous air pollutants.

PRECIPITATOR SYSTEMS

Foremost in present thinking regarding high efficiency dust collection for incinerators is the electrostatic precipitator. This device, while long used in American power plant practice, is yet to be applied to an incinerator in this country. Precipitators are capable of high collection efficiency at low pressure drop (about 0.5 in. w.c.). As with other collectors of high efficiency (such as bag filters or mechanical cyclones) gas cooling is required for protection of the precipitator from excessive temperatures. Although precipitators do not require the use of an induced-draft fan for pressure drop reasons, such use is normal, primarily to produce a steadier rate of combustion and consequent rate of gas flow, thus making performance more reliable and more predictable. Efficiencies higher than 95 percent are possible. Although this equipment has a high first cost, its total owning and operating costs may be competitive with other types of flue gas cleaning devices. While a precipitator has not yet been installed on an American incinerator, the new Des Carrieres Plant in Montreal, of 1,200 tons per day capacity, now under construction, will have electrostatic precipitator equipment. A number of plants in continental Europe have been equipped with precipitators, and the equipment is reported to operate in trouble-free fashion and at very high efficiency.[4] It is further understood that two new incinerators soon to be built for the City of London, England, will also be electrostatic precipitator equipped.

AREAS REQUIRING FURTHER STUDY

Although the foregoing indicates that we have progressed to some degree in the field of incinerator air pollution control, there are areas where continuous direct research, if available, would be very beneficial. Some of these things are being investigated by the ASME Incinerator Committee to the extent that is possible by volunteer researchers operating without facilities or funds.

The concentration of particulates in flue gases has been tested occasionally but generally the results have not been published. Published reports of tests have dealt with specific plants handling specific refuse, where tests were naturally made over short time durations. Refuse is a fuel which varies widely from day to day, hour to hour, season to season. Furnace stokers, with their differences in agitation methods and methods of underfire air introduction also contribute to the complexity of the problem. A long-term program, covering several types of plants, with varying types of operation of these plants is indicated before the full range of possible fly ash concentrations has been explored. Not only is the question of fly ash concentration relatively unknown, but also the particle size consist resulting from various types of plants being operated in various ways is a matter for some conjecture. Again, some test results are available, but these are short-term tests made only on a few types of plants.

It is hoped that the current Federal Government Research Grant and Demonstration Grant programs under Public Law 89–272 will help in these areas. With national interest at its present level, it is also hoped that more manufacturers will join the field to develop data which will be pertinent to their particular types of equipment.

Another development which would be of tremendous value would be a continuous readout monitoring instrument which would provide instantaneous knowledge of particulate concentration in flue gas at any time. The availability of such a device would lessen the cost of field tests and would thereby make data more readily available.

It also would provide a ready method of controlling the performance of any type of fly ash collection system to ensure maximum utilization of the inherent efficiency of installed equipment.

A specific hindrance to progress in the incinerator air pollution control field is lack of standardization, and perhaps careless use of the language which is used in expressing the criteria and performance. Units of limiting values are expressed in many ways in our existing codes and standards. This leads to inherent errors in making conversions from one set of units to another, and results in a good deal of difficulty in communication. The following methods of expressing particulate concentration are current in the literature today:

—Pounds emitted per million BTU input
—Pounds emitted per ton of refuse burned
—Pounds emitted per thousand pounds of flue gas at 50 percent excess air
—Grains emitted per standard cubic foot of flue gas at 12 percent CO_2.

With regard to the last item, there is a question as to the definition of a standard cubic foot. It may be expressed at either 58 deg. F. or 32 deg. F. Either temperature may be used as a standard and it is imperative to define which is being used. The use of both 12 percent CO_2 and 50 percent excess air is confusing, as these values are not exactly convertible until the type of fuel being burned is defined, although for normal refuse they are sometimes considered as being equivalent. This is not strictly accurate, and leads to unnecessary confusion. An additional variable which must be specified is whether the criteria are being expressed on a wet or dry basis. This, of course, makes a significant difference in the weight of the flue gas, particularly where a spray chamber or scrubber is used in the process.

Lastly, it is regrettable that it is not more uniformly recognized that particulate concentration alone is not representative of the air pollution potential for a given plant. Total gas volume emitted at the specified concentration is the real measure of the total amount of pollutants discharged. While some local codes do recognize this in terms of establishing two or three ranges of allowable emission concentrations, the practice is nonuniform in this respect. It seems only logical that equitable codes should provide a maximum limit for the total amount of pollutant emitted from each source, and that large potential polluters would therefore be required to install control equipment of greater efficiency and that insignificant pollutors would be spared unwise expenditures.

In general, then, there is work to do on the part of both those who design, build, and operate our plants; and those who establish the criteria within which these things will be accomplished. By mutual work for better understanding progress will come more rapidly, and at less cost in the long run.

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DISCUSSION

CONTROL OF AIR POLLUTION FROM MUNICIPAL INCINERATORS

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The subject of control of air pollution from municipal incinerators is a complex one. In his paper, Mr. Fife has done an excellent job of presenting an up-to-date coverage of the problem, with particular attention devoted to the available systems for the control of particulate emissions. He rightly has pointed out that particulate emissions, at the present time, constitute the principal area of interest and concern. Mr. Fife has directed attention to the fact that few actual air pollution performance data have been published in the literature, despite the fact that much work in this field has been performed.

It is hoped, as Mr. Fife suggests, that those persons administering Public Law 89–272, the Solid Waste Disposal Act of 1965, will take steps to make the comprehensive data on municipal incinerator air pollution performance that do exist available in a state-of-art report. It is axiomatic, of course, that we know where we are before we can make meaningful judgments and decisions as to where we can go and should be going.

A number of investigators have reported on the minor nature of the municipal incinerator gas phase air pollution problem—sulfur dioxide, oxides of nitrogen, carbon monoxide, hydrocarbons, and carbonyls. These results are quite understandable when one appreciates the nature of the fuel and the present design practices of providing extensive high temperature retention time in municipal incineration systems. Table I depicts the ranges of some of the results that have come to the writer's attention.

It is apparent from the table that gas-phase pollutants constitute only a minor part of the municipal incinerator air pollution problem. Fortunately, this is the situation since no practical, efficient control systems have been developed for removing either sulfur oxides or oxides of nitrogen, the two most prevalent gas-phase pollutants, from the effluent gas stream.

Unfortunately, while there is a general concurrence in the relatively minor nature of the municipal incinerator gas-phase air pollution problem, there is a widespread divergence of opinion as to the extent of the particulate emission problem associated with modern municipal incineration. Lack of information, and the tendency to generalize on certain kinds of information, often lead to conflicting and contradictory evaluations of the extent of the municipal incinerator particulate air pollution problem. As an

TABLE I.—*Gas-phase air pollutants from municipal incinerators*

Pollutant	Concentration (ppm-volume)	
	Range	Average
SOx as SO_2	20-460	250
NOx as NO_2	9-220	70
CO	[1] 0-2,600	25
Total hydrocarbon	[1] 0-260	2
Carbonyls	10-60	20

[1] Poor combustion.

example, Mr. Fife cites a 1965 report titled "Air Pollution In New York City" which suggests that the city's 11 municipal incinerators daily contribute 35.5 tons of particulates to the city's daily total discharges of 225 tons (15.8 percent). By the same token, the 1966 Report of the Mayor's Task Force on Air Pollution in the City of New York suggests that the same municipal incinerators discharge particulates at the rate of 38.6 tons per day of a total city daily particulate release of 630 tons (6.1 percent).

These examples point vividly to the large amounts of misleading and contradictory data being carelessly bandied about in the air pollution field—spurred on a lot by only token evaluation and assessment of the problem and often by the desire to "sensationalize" on it.

In the first place, I have always shuddered when figures on New York's municipal incinerators are cited as being in any way typical of modern incineration practice. The newest New York municipal incinerator was built in 1962 and incorporated very inefficient water sprays as the fly ash removal system. None of the New York incinerators have effective particulate control systems. The sudden realization of this situation in New York has recently prompted the city to initiate a "crash" multimillion dollar municipal incinerator program to evaluate five different particulate control systems. It is interesting to note that the performance of all but one of these five systems is now predictable to a high degree of certainty based upon actual performance data presently existing. The New York situation must be considered anything but typical.

Table II illustrates the relative contributions of various fuels to a community's particulate air pollution problem. The estimates are indicative only and do not reflect probable wide variations caused by rates of operation, fuel composition, efficiency of combustion, methods of firing, air distribution, efficiency of collection, etc. The data do represent generalizations based upon many tests of actual field installations.

TABLE II.—*Estimates of controlled particulate emissions from combustion processes*

	Particulate per ton of fuel burned, pound			
	Coal (13,000 BTU/#)[6]		Oil [7]— All sizes	Refuse [8]— Municipal incinerators
	Utility plants	Industrial		
Average performance	25	25	2-10	3-10
Good performance	10	15	2-4	3-5

NOTE.—See references at end of article for footnotes.

From Table II, it can be seen that modern controlled municipal incinerators discharge particulates at approximately the same levels as those associated with fuel-oil burning. It is further interesting to note that there appears to be little widespread sentiment being expressed for the installation of electrostatic precipitators, or more effective particulate control systems for oil-fired installations. However, this is not the case with regard to municipal incinerators. Too often the sentiments along this vein are expressed by the uninformed or the alarmist—a condition that a comprehensive state-of-art presentation with regard to modern municipal incineration air pollution performance may well rectify.

The above figures must further be interpreted in terms of a community's total fuel consumption of the various types of fuels listed and of the contributions of other fuels (gasoline) and noncombustion sources.

As an example, we in Milwaukee County, who have pioneered in the field of municipal incinerator air pollution control with one of the Nation's first such effective systems, in operation since 1954, consider our municipal incinerator particulate effluents of less than two tons per day to be considerably less than 1 percent of our total particulate emission problem. Incidentally, our Milwaukee plants which normally discharge particulates in the range of 0.7 to 0.9# dust/1000# flue gas, corrected to a 50 percent excess air basis, have never received a single justified complaint in over 10 years of operation. Unfortunately, many previous evaluations of this sort have often used the poorer performing municipal incinerators in comparing the contribution of these units to a community's total problem.

In his paper, Mr. Fife spoke rather disparagingly of the old "smoke abatement" laws and their reliance on stack gas density or opacity as the means of establishing emission limits. It should be pointed out, however, that most of the old "smoke abatement" laws, at least those in the major cities which have air pollution control programs, also incorporated limitations of permissible dustloadings. In fact, the so-called modern "air pollution control" ordinances of today most often have the same type emission limitations (visual and dustloading or mass emission rate) that characterized the old "smoke abatement" laws. The problem here has not been the laws or limitations but a lack of ability or desire, or appreciation of the need, to evaluate particulate emission performance. This condition was largely created by the complexity, the lack of financial support for, and the hazardous and time-consuming nature of, the testing process. The significant strides forward that have been made in the field of municipal incineration particulate emission control have been largely attributed, by some, to the efforts of those control agencies, individuals, consultants, contractors and groups that have pioneered in the need for and conduct of performance evaluations. When one considers that the matter of effective municipal incinerator air pollution control is less than 12 years old, it can be seen that great strides forward have been made in this short period.

It would be difficult to discuss the field of municipal incinerator air pollution control without commenting on the widespread misunderstanding that exists among all parties when the expressions spray chambers, wet baffle collectors and scrubbers are used. There have been adequate data and study in the science of dust collection to dramatically illustrate the ineffectiveness of strictly spray-collector-type dust control systems. Unfortunately, there have been numerous amateurish attempts at the design of incinerator spray collection systems. Only in recent years has there been a growing awareness that there is much more to the design of an effective wet-type dust control system than merely the injection of water spray into a dirty gas stream. The ineffectiveness of the mechanism of "collision" of dust and water particles in a hot, dirty gas stream has long been known to the informed designer of dust control systems. Even to this day few people in the field appreciate that "impingement" against wetted surfaces is presently the most effective mechanism used for wetting and retaining particulates in a wet collection system. This deep seated misunderstanding of the dust collection process has led to the use of copious quantities of water in many wet collector systems—water which has done little, collection-wise, but which has cooled and saturated effluent gas streams.

It has been reported many times in the literature, and it has been demonstrated in many dust collector applications, that the efficiency of dust collection is directly related to the energy input (gas or water phase) in a wet collector system. Municipal incinerators are no different in this regard from any other application. The basic question has never been *how* to do the job of dust control on this application but *how far* one should be expected to go to provide nuisance-free and relatively air-pollution-free performance. And along with the same question there has always been the related question of how we can achieve this level of performance in the least complex, least costly, most maintenance-free, and most reliable system.

Great care must be practiced in relying on only a strict cost analysis of various control systems in the absence of complete knowledge of the air pollution performance levels achieved, and the related problems of availability and reliability of the systems. A word of caution is offered on this point because some of the control systems discussed, and presently available, have not produced the desired end results. As pointed out, there is not yet a single full-scale bag house or electrostatic precipitator installation in this country on either a conventional refractory type American incinerator, or on one of the integral boiler-incinerator units which characterize European design.

There are rather profound differences between European and American incineration practices. European refuse is generally wetter, higher in incombustibles, and of lower calorific value. The European units operate in the 50 to 70 percent excess air level range, as compared to our American air- and water-cooled refractory lined units which see 300 to 700 percent excess air levels at the stack. At present we have no experience to cite or to demonstrate the expected performance and related problems of operation of bag collector and electrostatic precipitator application.

It should be remembered, whether a boiler system is used, or whether water- or air-cooling is used to reduce temperature to acceptable levels for these complex systems, that there are often times when our refuse exceeds 60 percent in moisture content during extended rainy seasons. This heterogeneity of the refuse, particularly with respect to moisture content, can be expected to present some serious corrosion, maintenance, and performance problems for any complex collection system.

It may well be that economics will dictate the increasing use of integral boiler-incinerator installations in this country. This determination should not be colored, however, by the *need* to provide the claimed air pollution performance levels of electrostatic precipitators. Such a requirement would truly be a case of the tail wagging the dog.

Air pollution control is achieved in all combustion processes by other means than merely cleaning of the exhaust gases. Other important considerations that must not be overlooked relate to the character and the nature of the fuel, the design and operation of the combustion system, and finally, the manner in which the remaining pollutants are discharged to the atmosphere. Some of the limited published data available discuss the effects of incinerator design, rates of operation, grate or burning systems, and air distribution on the emission performance of municipal incinerators. Some of these data clearly outline the profound effect on furnace and stack particulate emission rates of these design and operating variables.

While little has been published in the literature, practical experience has dictated a growing awareness of the need for high stacks for municipal incinerators. This requirement is not dictated by the needs in normal operation of such plants but by the unusual operation, or operation during those periods when the air pollution potential of a municipal incinerator is at its greatest—such as startup, burndown, low furnace temperatures, wet refuse, and breakdowns. Esthetics of low stacks should be seriously weighed against this functional requirement.

Despite all the problems and concerns expressed in both Mr. Fife's paper and in this discussion, I believe that we are in complete agreement that modern municipal incineration offers the best promise, the most satisfactory practice, the most pollution-free performance from a total environmental pollution standpoint (air, water, and land), and the best overall method of solid waste disposal available to the vast majority of our communities today.

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CONTROL OF AIR POLLUTION FROM INDUSTRIAL AND HOUSEHOLD INCINERATORS

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Refuse disposal is an increasingly important problem, since it involves many facets of present-day living, namely air pollution, water pollution, fire-safety, health, traffic flow, noise, economics and security. None of these factors can be entirely separated from the others; yet the publicity that air pollution has received in recent months, and the resultant panic from this publicity, have made us forget that other problems must be faced.

"On-the-site" incineration, whether it be in the home, the industrial plant, the hospital, or the research center, most nearly solves all the problems in the disposal of combustible waste. A modern well-designed incinerator can be operated without creating objectionable air pollution. "On-the-site" disposal eliminates the fire hazard and vermin problems created by the storage of waste while awaiting collection for disposal in another area. Immediate disposal by incineration on the site reduces, if not eliminates, the health hazard if the waste is infectious.

The collection of wastes for disposal in an area other than on the site creates traffic problems and certainly the noise of garbage and rubbish pickup is objectionable, especially if it must be done in the early morning hours to avoid traffic problems. Most communities are not prepared to absorb the additional work load with their present collection equipment and present manpower, nor are they prepared to dispose of the additional volume and weight of refuse if "on-the-site" disposal is discouraged.

"On-the-site" incineration is the only apparent answer to the disposal of waste, when its complete disposal is necessary for security reasons.

Therefore incineration in the home, the industrial plant, the hospital or the research center should not be outlawed now should the air pollution codes be made so restrictive as to make "on-the-site" incineration uneconomical for the owner.

According to surveys made, refuse disposal contributes only 4 to 5 percent of all air pollutants and certainly the greater portion of this small percentage is created by the outdated or undersized incinerator, or is created by equipment referred to as an incinerator, but which is in fact, merely a firebox, an open pit or a wire basket.

Charts I and II show air pollutants of various kinds and also the sources of the contaminants. Chart I gives the air pollutants totaling approximately 130,000,000

CHART I

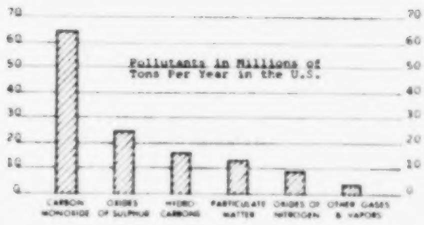
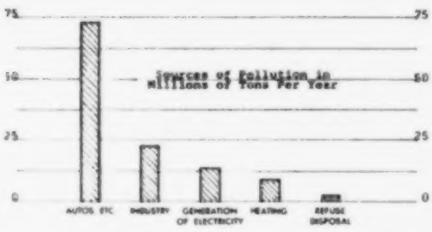


CHART II



tons per year. This chart shows the tons of particulate matter from all dust-producing sources at approximately 13,000,000 tons or 10 percent of the total.

Chart II gives the sources of air pollution gauged in millions of tons per year and shows refuse disposal as the smallest source, or 4 percent of the total.

Not only is the population increasing, but so also is the per capita production of refuse. In 1920 the average person threw away 2.75 pounds a day. Now refuse production is 4.5 pounds and it is growing at the rate of 4 percent a year. In many cases the municipally-owned incinerator or incinerators cannot be operated within the city's own air pollution codes because they are outdated or taxed beyond their normal capacity.

Some industries dump waste onto the land, others into rivers, because that is their cheapest recourse. If they process their waste, the prices of their products rise and the cost is passed on to the public. In homes, multiple dwellings and high-rise apartments, the solid waste must be incinerated at reasonable cost with the tenant absorbing the cost, or the solid waste must be collected by municipal forces, adding to the city's traffic and noise problems, and with the cost of collection and disposal passed on to the public. In each case there must be a value judgment. The question is how pure must the air of a community be to protect its health, satisfy its recreation needs, yet not cripple its economy?

It would appear to the uninformed that the use of the industrial and household incinerators for refuse disposal would only add more impurities to the air we breathe. But, on the contrary, these incinerators offer much more to a community or area than a solution to only one phase of our refuse disposal problem.

It has become increasingly more expensive to collect refuse by trucks for centralized disposal. The disposal of waste by burial or land fill becomes more of a problem and more costly too, as available sites fill up, or are reached only by trucking greater distances.

All indications, therefore, point to the need for "on-the-site" refuse disposal and a growing demand for residential, institutional, commercial, and industrial incinerators. This will continue as a growing demand, as a logical solution to solid waste disposal, but only if the air pollution codes do not become so restrictive as to make the capital investment and operating costs prohibitive.

The incinerator industry has learned that a properly proportioned multiple-chamber incinerator can, with reasonably good operating and maintenance care, be operated without creating a nuisance. We know from the results of tests that when burning Types 1, 2, 3, and 4 wastes, such units will not create in the combustion process, and therefore not discharge to atmosphere, any toxic or poisonous gases, and with proper air supply and temperature, odors are eliminated, and smoke density is held within the present day requirements.

Much work remains to be done in the control of particulate matter (fly ash and dust) from incinerators and in determining how properly and accurately to measure these emissions.

It is generally conceded that we are principally interested at this time in the following three categories of incinerator effluents: smoke density emissions, odor, and particulates. With a trend toward greater increases of special solid wastes, in any mixture a wide range of gaseous effluents is possible and some day additional attention must be directed to these gaseous discharges. However, at this time we must direct our principal attention to the nuisance-type discharge from incinerators, smoke, odor, and fly ash.

The present nationally accepted method of measuring or gauging smoke density is by a visual comparison with Ringelmann charts, as published by the U.S. Bureau of Mines. Odors are detected and evaluated by the human sense of smell. From a strictly scientific standpoint, these determinations leave much to be desired, but they are nationally accepted, and both are simple and reasonably accurate, and can be made at little or no cost.

However, measuring for particulate matter is an elaborate and expensive procedure, which requires costly instruments and complete laboratory equipment as well as the services of specially trained technical personnel. Present test methods can be grouped into three general categories. One test method is detailed in the American Standard Association publication, *Approval Requirements for Domestic Gas-Fired Incinerators*, and is used almost exclusively in the performance testing of domestic incinerators not exceeding four bushel capacity. Another test procedure is the low-sampling-volume technique and is a modification of the procedures outlined in the Western Precipitation Corporation Bulletin WP–50, *Methods for Determination of Velocity, Volume, Dust and Mist Content of Gases.* The third general-type test technique is the large sample volume method and is a modification of the procedures outlined in the ASME Power Test Codes PTC 27–1957, *Determining Dust Concentration in a Gas Stream*, and PTC 21–1941, *Dust Separating Apparatus*. This third test technique is the method most generally referred to by air pollution authorities in their updated codes and new proposed codes.

The sampling equipment required in the field weighs approximately 800 pounds and at least two men are required to set up and operate the equipment. The cost of a single test ranges between $1000 and $3000, depending upon the distance between the laboratory and the incinerator site, accessibility to the incinerator, and duration of the test. However, in many instances the cost of the test equals or exceeds the cost of the incinerator equipment. The accuracy of the test depends entirely on the experience of the technical personnel, their judgment of sampling location, and the care which is exercised in withdrawing representative samples from the gas stream.

Needless to say, the cost and the inconsistencies of the results of the tests have discouraged the testing of incinerators. Most air pollution authorities do not have the equipment or the trained technical personnel to conduct these tests. The incinerator industry has given serious consideration to the purchase of equipment and hiring of the technical people necessary but in many areas the test results would not be accepted, not having been done by a "recognized testing laboratory."

The need for a simplified form of testing procedure to determine particulate emissions from incinerators cannot be too strongly emphasized. The equipment must be light enough to carry in the trunk of a car, must be simple to operate, preferably by one man, and be direct-reading or require a minimum of laboratory calculations, so that a quick determination of particulates being emitted can be made. The lack of uniform testing procedures and equipment and of national recognition by all controlling authorities is discouraging the incinerator industry from making meaningful tests, and the industry thereby suffers from a lack of significant data to improve its product.

The Incinerator Institute of America, for the incinerator industry, requests a unification of nomenclature and permissible performance criteria, for proper and better liaison between industry, engineering societies, research laboratories, and the air pollution authorities. Two typical examples are given, as follows:

1. lb. of particulates per 1000 lb. of flue gas corrected to 50 percent excess air (or to 12 percent CO_2)

2. grains of particulates per standard cu. ft. of air, corrected to 50 percent excess air (or to 12 percent CO_2).

These are just two examples, others are being issued with some of the necessary terms or conditions omitted, through either oversight or misunderstanding.

It is recommended that these many varying terms and conditions be expressed in uniform terms, acceptable to all controlling authorities. We further recommend that the present terms be replaced by, or supplemented by, terms readily understood by all, namely to express the permissible particulate emissions in pounds per hour per pound of refuse charged into the incinerator. This is simple and, since no correction factors are involved, the various codes can be readily compared and the expression understood by everyone, including the general public.

No incinerator which burns type 0, 1, 2, 3, or 4 waste is operated using only 50 percent excess air, nor is any operated which produces an effluent with 12 percent CO_2. In normal operation the excess air is in the range of 100 to 200 percent, producing CO_2 of 3 to 5 percent. The elimination of correction factors will reduce laboratory and engineering calculations and reduce costs and the dangers of human error.

Much if not most of the residential, commercial, and industrial waste with which we are concerned has a chemical analysis and calorific value such that 7 pounds of theoretical dry air is required per 10,000 B.T.U. in the refuse. At 50 percent excess air, the dry air required is 10.5 pounds for each 10,000 B.T.U. heat release.

Therefore, by simply adding together the air, the moisture, and the ash and moisture-free combustibles, the total weight of flue gas can be determined. When auxiliary fuel is used, its weight and the required air must be added to obtain a total.

The calorific value of the waste or of test refuse can be closely estimated from tables in authoritative sources. Similarly, the moisture and ash content of either mixtures of waste or test refuse can be determined from published acceptable data.

As an example, the description of type 0 waste as given by the Incinerator Institute

CHART III

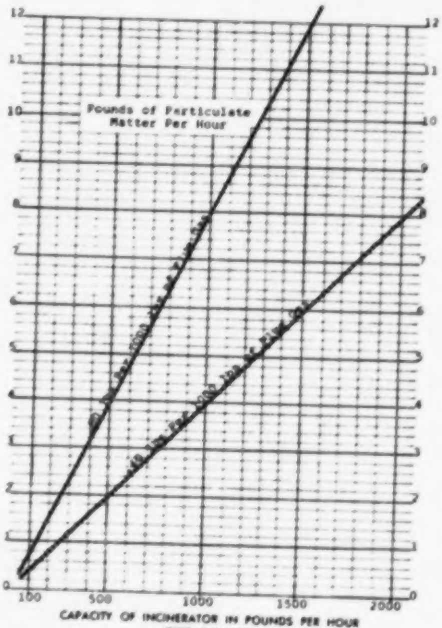
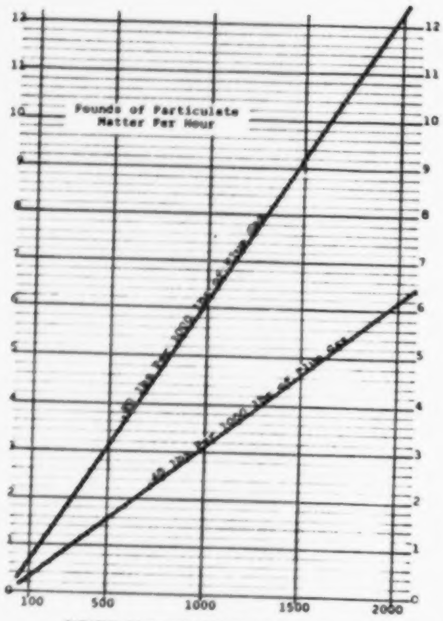


CHART IV



of America, is accepted by air pollution authorities as trash produced by industrial establishments and contains 10 percent moisture, 5 percent incombustible solids, 85 percent combustibles, and has a calorific value of 8500 B.T.U. per pound as fired.

The description of type 1 waste is also acceptable to air pollution authorities as general rubbish produced by most commercial and many industrial establishments. Such rubbish contains 25 percent moisture, 10 percent incombustible solids, 65 percent combustibles; and has a calorific value of 6500 B.T.U. as fired.

Similarly, type 2 waste, a 50–50 mixture of rubbish and garbage produced in the home and most apartment houses, is acknowledged to contain 50 percent moisture, 7 percent incombustible solids, 43 percent combustibles; and has a calorific value of 4300 B.T.U. per pound.

From such data it is simple to determine the total hourly permissible discharge of particulate matter from any incinerator, or charts can be used when the waste is type 0, 1, 2, 3, or 4 as defined by the Incinerator Institute of America. By referring to a chart or by having prepared calculations prior to a test, it becomes unnecessary to make any other corrections; CO_2 or Orsat and even temperature reading are no longer essential.

Charts III, IV, and V show the simplicity of such an approach.

Chart III is based upon type 0 waste, and shows the hourly discharge of particulate matter, with one curve based on a discharge of .80 lbs. per 1000 lbs. of flue gas corrected to 50 percent excess air, the other curve based on a discharge of .40 lbs. per 1000 lbs. of flue gas corrected to 50 percent excess air.

Chart IV is based upon type 1 waste and shows the hourly discharge of particulate matter, again with one curve based on a discharge of .80 lbs. per 1000 lbs. of flue gas and the other curve based on a discharge of .40 lbs. per 1000 lbs. of flue gas, both corrected to 50 percent excess air.

Chart V shows the hourly discharge when burning type 2 waste, again showing the two curves.

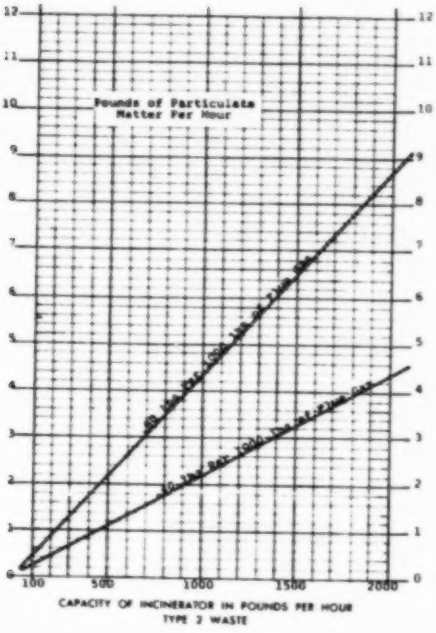
It is interesting to note that New York State, in its proposed code, recognizes this simpler and more readily understood approach and includes a chart in its proposed *Current Guides for Prevention of Air Pollution from Incinerators.*

The procedures to be followed in the charging of the incinerator during a test run, must also be established and agreed upon. Such charging, stoking and leveling of the fire-bed procedures must form a part of any test run to provide uniformity in testing and must be nationally recognized by all controlling authorities. During sampling for particulate matter, is the incinerator to be fired with shredded newspaper and cardboard in carefully prepared charges, or is the incinerator to be charged with refuse, following procedures as in the normal incinerator operation?

From the limited amount of testing which has been carried out to date, industry has been able to form the following conclusions:

1. That an incinerator, designed and built in accordance with the Incinerator Standards of the Incinerator Institute of America, can be demonstrated to operate at capacity and not emit particulate mat-

CHART V



ter in excess of 0.80 lbs. per 1000 lbs. of flue gas corrected to 50 percent excess air. Some visible fly ash may be apparent but the quantity is unknown.

2. That if a "low-resistance" wet scrubber is added, the installation can be operated at capacity and not emit particulate matter in excess of 0.40 lbs. per 1000 lbs. of flue gas corrected to 50 percent excess air and with 99 to 100 percent of the visible fly ash removed.
3. That during neither of the above demonstrations will smoke be emitted darker than No. 2 of Ringelmann charts for a period or periods aggregating more than three minutes in any one hour.

Industry also knows that "high-resistance" wet scrubbers can be used in lieu of, or in addition to, the low-resistance scrubbers, but insufficient data preclude a conclusion as to the efficiency gained by their use. Industry, therefore, concludes that the additional capital investment and operating costs far exceed the benefits received unless the additional cost can be justified by health or security reasons.

Chart VI shows graphically the relative costs of incinerator equipment to meet certain particulate emissions. The costs shown represent the capital investment for the incinerator equipment, with no allowances made for cost of foundations, building to house the equipment or its operating space, nor the chimney. Neither does it reflect operating or maintenance costs. Curve No. 1 represents the cost of an incinerator designed in accordance with the Standards of the Incinerator Institute of America, with emissions not exceeding 0.80 lbs. per 1000 lbs. of flue gas corrected to 50 percent excess air. Curve No. 2 represents the cost of an incinerator with a "low-resistance scrubber" and induced draft fan, with emissions not exceeding 0.40 lbs. per 1000 lbs. of flue gas corrected to 50 percent excess air. Curve No. 3 represents the cost of an incinerator with a "high-resistance scrubber" and induced draft fan, with the emission limits lower than 0.40 lbs., possibly in the range of 0.30 or 0.20 lbs. per 1000 lbs. of flue gas corrected to 50 percent excess air.

CONCLUSIONS AND RECOMMENDATIONS

1. A standardization of expressions of acceptance limits of particulate emissions, or a "common yardstick" throughout the country, must be established.

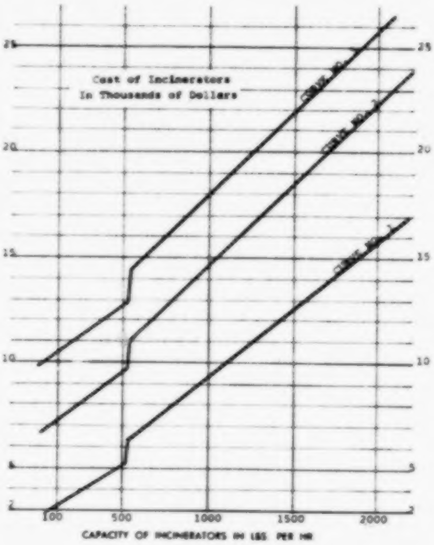
2. A standardization of acceptable test procedures which are practical and economical must be developed and agreed upon.

3. Pending the development of practical test procedures, and time to analyze the results, no one really knows what constitutes particulate emission limits which are restrictive to the point of discouraging or eliminating on-the-site incineration.

4. Until such time as the air pollution authorities can themselves perform such tests as are required to prove compliance or non-compliance, it is recommended that their criteria be couched in general terms and reliance placed on visual observations.

5. Prohibiting the installation of the new modern incinerator still leaves the problem of the disposal of solid wastes. This problem cannot be "swept under the rug" to placate

CHART VI



complaining citizenry without first presenting practical alternate solutions which are better.

6. To help protect the air pollution authorities from the irate taxpayer, there exists a requirement for a new identity for the multiple-chamber incinerator to remove from the public eye the stigma which exists, and which relates actually to the old fashioned flue-fed incinerator, the backyard incinerator, and the wire basket.

For better public relations, the incinerator industry recommends the use of the word "destructor" when referring to a multiple-chamber unit, which has an hourly-rated capacity and can be guaranteed by the installer to operate within reasonable air pollution regulations.

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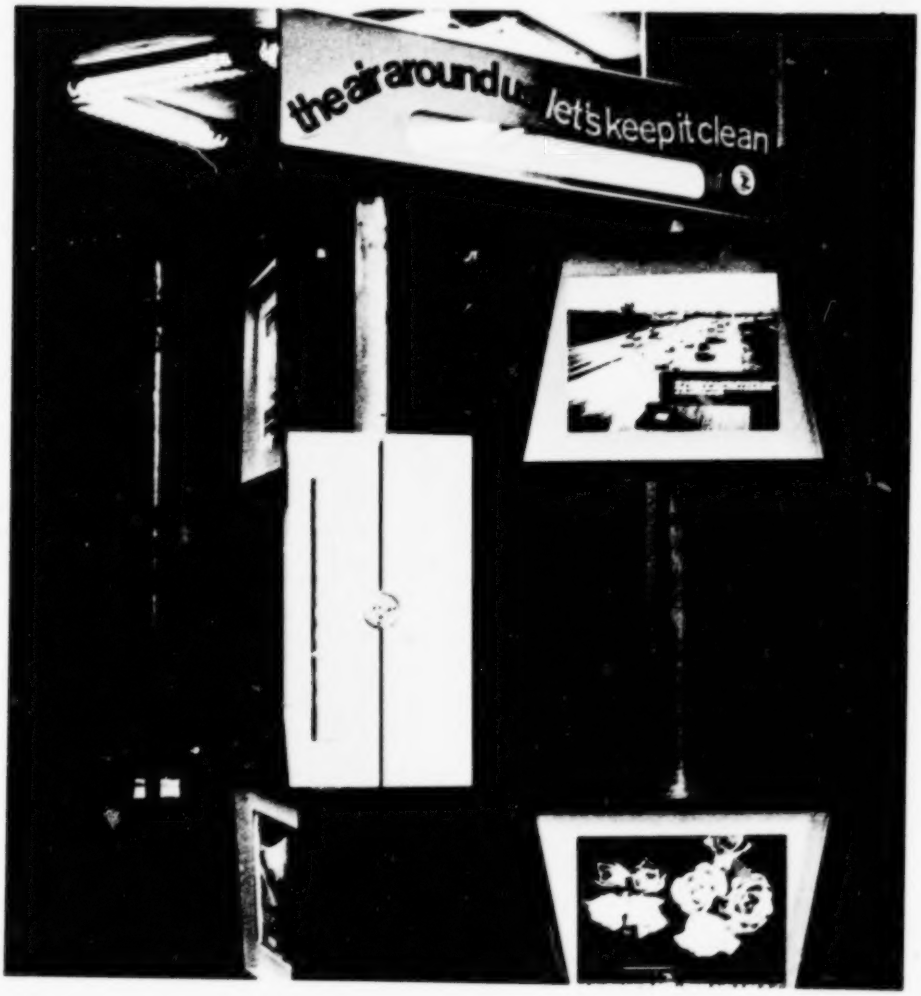

". . . chemical engineer with masters in public health . . . in charge of Philadelphia's air pollution control program until 1966 . . ."

DISCUSSION

CONTROL OF AIR POLLUTION FROM INDUSTRIAL AND HOUSEHOLD INCINERATORS

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Let me preface my discussion with the statement that my comments apply primarily to the nature of the problems in the Philadelphia metropolitan area. However, many aspects of this problem are similar in other major metropolitan areas. The term "industrial" as used here is meant to include commercial units in stores, apartment houses, institutions, etc., as well as relatively small industrial incinerators.

A thorough evaluation of the relative importance of pollution emission in an urban community would reveal that incinerators are of significant concern. An emission inventory conducted in Philadelphia in 1959 indicates that for the major pollutants (oxides of sulfur, oxides of nitrogen, particulate matter, and total hydrocarbons), incineration processes contribute about 5 percent by weight of the total emission. This figure is in general agreement with those cited earlier in this discussion. However, the objectionable nature of substances released from incinerators results in a far greater effect on the community than these figures would indicate. Evaluation of air pollution complaints and inspectional data conducted by machine tabulation methods, developed in Philadelphia in 1964, lead to this conclusion. Of the 4,145 air pollution investigations in Philadelphia during 1965, 628, or 15.1 percent, involved excessive smoke, odor, or fly ash emissions from incinerators. These data are for industrial and commercial units only, with municipal and domestic facilities excluded.

Present regulations in Philadelphia limit particulate emission from all sources to .85 lb. per 1000 lb. of flue gas adjusted to 12 percent CO_2. Smoke is limited to less than Ringelmann 2 except for two minutes duration permitted in excess of that density.

In 1965, there were 644 violation notices issued for all sources of air pollution emission. Of this total, 101 notices, or 15.7 percent of all the nuisance emission violations, were caused by incinerators.

More than half of the problems arising from incineration processes are created by units considered acceptable in design by the bulk of the incinerator industry. It should be emphasized that, although incinerators release only 2 to 5 percent of the total air pollutants, they are responsible for 15 or 16 percent of the total reaction to air pollution as expressed in terms of community nuisance and property damage.

A program for dealing with old incinerators, mostly single-chamber chute-fed units, was initiated in Philadelphia several years ago. Owners and operators of old equipment were asked to repair neglected units and to become proficient in proper methods of operation and maintenance. Additions that were required included auxiliary heat burners, barometric dampers and flue gas washers where necessary. After these alterations are made, although violations are usually not eliminated, emissions can be reduced to a minimum if proper operational procedures are followed.

This involves strict adherence in converted units to batch-type operation. The general procedure includes charging refuse to the unit; preheating the secondary combustion zone; ignition and complete burn-down of the refuse; closing off draft and removing residue prior to recharging.

All new incinerators must be approved in the design stage, prior to installation within the city of Philadelphia. Present design requirements include multiple chambers, auxiliary heat and draft regulation devices. Since early 1965, additional requirements have included fly ash control by means of a gas washer. This is nothing more than a wet baffle impingement chamber or a water surface impingement chamber, not a high pressure drop water scrubber. For chute-fed units, charging dampers are required and completely separated charging chutes and exhaust gas flues must be installed. All these requirements have helped reduce emission from industrial and commercial incinerators. However, the nuisance and emission violation date for 1965, cited above indicates that further improvements are required to make these incinerators compatible with the desired urban environment.

Because of continuing problems created by incinerator emissions and the demand for cleaner air, control officials have recently begun to draft more stringent regulations. As indicated by Mr. Voelker, limitations on fly ash emissions are the most controversial aspect of most of these new regulations. Although the particulate emission limit should be as low as is practicable, considering both economics and desired improvements in air quality, it must be stressed that there is no direct relationship between average gravimetric emission levels (obtained by present testing methods), and the potential for nuisance or property damage that the incinerator can create.

In my opinion, developments must lead to the elimination of practically 100 percent of the visible, nuisance-type fly ash and the obnoxious odor emissions. Once this is achieved, control of the remaining particulate matter is approximately .4 lb. per thousand lb. of flue gas adjusted to 12 percent CO_2, appears to be adequate from the standpoint of air quality. The development of incinerator emission codes on the basis of pounds emitted per pound of charge, as in the case of the New York State code, is in my opinion a desirable standardization. I am also in agreement that emission test procedures must be evaluated, streamlined and standardized wherever possible. But, I believe that a nuisance emission evaluation should be a part of each source test. This refers to measurement of visible fly ash, collected either by impingement or filtration, and an evaluation of detectable odors. All tests should be conducted under normal operating conditions, not during periods of special handling or special operation of the incinerator.

The majority of incinerators now being sold will not meet the emission requirements of .4 pounds, adjusted, and zero nuisance emissions during normal use. In my opinion, the fault is largely due to improper design from the standpoint of practical operating conditions. There are several areas where design considerations are especially pertinent: (1) Attention must be focused on the volume of material to be burned when considering the capacity of an incinerator. It would be most desirable for an incinerator to be designed so that it could not be overcharged with an excess volume of refuse in the combustion chamber. (2) Present design is not adequate to allow intermittent charging without the creation of unreasonable amounts of air pollution. Charging of refuse to the unit while material is being burned results in uncontrolled draft and improper combustion. Therefore most of the units that are presently designed for handfiring or chute-charging are acceptable only for batch-type operations. If continuous operation or intermittent charging or some halfway point between these two is desired, substantial design changes must be incorporated into the incinerator in order to minimize nuisance emissions. (3) A continuous effort must be made to train incinerator operators more adequately. There are still occasions when ashes are removed from the ash pit of an incinerator by allowing a good draft to pass through the unit. (4) For many practical reasons there will probably not be rapid improvements in the degree of training received by incinerator operators. Therefore, a somewhat more mechanized operation must be developed to compensate for these inadequacies that can be expected. Automatic timers and regulators for burner control, damper control, etc., must be considered.

I wish to make a few comments regarding experiences with domestic incinerators. Emission tests have been conducted by the Philadelphia Air Pollution Control Section on several different makes of domestic incinerators. As would be expected, the results of these tests showed great variation, but, in general, the particulate emission per pound of refuse burned was found to be somewhat lower than the average for larger industrial or municipal units, while emissions of total hydrocarbons were considerably higher from the small domestic units on a per pound charged basis, than from their larger counterparts.

Incinerators previously tested for emissions were installed in four test areas within the city. Opinion surveys were conducted to evaluate the degree of nuisance or other problems created in neighborhoods where home owners used incinerators on a regular basis. Construction of housing in the survey areas was of the "twin-home" type, and housing density was below the citywide average. It was found that 24 to 52 percent of the persons surveyed had noticed smoke, odor or fly ash from domestic incinerators and 12 to 16 percent of those interviewed found the situation annoying. Many of those persons annoyed by the emission detected in the neighborhood or within their own homes had actually stopped using their incinerator.

Because of the survey results and because there is adequate municipal collection of domestic refuse in Philadelphia, the use of domestic incinerators has been discouraged. It is my opinion that the cost per pound of charge for these small units, when equipped with adequate air pollution control devices, is substantially greater than alternate disposal methods.

Atmospheric emissions from industrial and commercial incinerators are a prime contribution to the air pollution problem in any urban community, based upon the weight rate of emission plus nuisance and property damage effects. Control of emissions must emphasize 100 percent removal of visible fly ash and nuisance odors in addition to a practical smoke and particulate emission limit. Changes in design will, I think, be required to achieve this degree of control during normal incinerator operations. Of major importance are volumetric capacity, proper batch-type operation, and the mechanization of certain procedures. Flue gas washers appear to be effective for the elimination of visible fly ash emissions from industrial and commercial incinerators of contemporary design. There is, however, every reason to assume that further design improvements can be achieved that will reduce emissions sufficiently to eliminate the necessity for washers. Domestic and small industrial-commercial incinerators have not proved satisfactory in the urban Philadelphia area.

". . . attorney . . . former assistant district attorney of New York . . . member of Congress since 1960 . . . member of Science and Astronautics Committee . . . deep interest in air pollution problems . . ."

A CONGRESSIONAL VIEW OF THE PROBLEM

WILLIAM F. RYAN
U.S. Representative,
20th District
New York

I come as you know, from a heavily polluted area. In New York City, we are in the midst of a continuing smog emergency. When the polluters have seriously injured, if not killed, many of our people, it is a particularly fitting time for a National Conference on Air Pollution to be held.

As a Congressman from New York City, I am, of course, primarily interested in the problems and potential solutions available in metropolitan New York. In our area, for better or for worse, most of the conferences, meetings, discussions and arguments have contributed far more hot air than abatement to the problem of air pollution and solid waste disposal.

One month from now on January 17, 1967, the Interstate Sanitation Commission of New York and New Jersey will celebrate its thirty-first birthday. For 31 years the Commission has contributed little or nothing to solution of the interstate pollution problem. New York City remains the most polluted area in America. New Jersey continues to contribute something like one-third of that air pollution. For some time Federal officials have been planning a Federal air pollution abatement conference for the New York City-New Jersey area. Such a conference is the essential first step in the enforcement procedures spelled out in the Clean Air Act.

Over Thanksgiving, New York City had a smog emergency. The only way the city avoided disaster was by shutting down incinerators and temporarily stopping disposal of solid wastes. In the midst of that emergency I called upon the Secretary of Health, Education, and Welfare to summon an abatement conference and I am pleased that on January 3 it will get under way.

Our national conferences have spent considerable time on the problems of air pollution from motor vehicles, fuel combustion, and various manufacturing processes. Such pollution made up the bulk of the agenda for the conferences four and eight years ago. It makes up the bulk of the agenda for this conference. But solid waste disposal is certainly as great a problem, for we are facing a disaster in solid waste disposal. If we find ourselves at a conference some eight years from now without having taken the necessary and appropriate action, then we will be only contributing more hot air to the problem because we will be in the midst of another serious emergency.

Each year Americans have to dispose of some 30 million tons of paper and paper products, 8 billion pounds of plastics, 48 billion cans, 26 billion bottles and jars, plus more than a half billion dollars worth of miscellaneous packaging materials, to say nothing of garbage.

Our disposal disaster is going to get worse. Urbanization, population growth, stepped-up industrial production are all increasing the problem. We Americans are moving into urban areas closer together. We are increasing in numbers. We are turning out more "throw-away" packaging and other refuse. We are, each of us, creating more and more refuse. The average American today throws away twice as much refuse as his father did. If present trends continue, each of our children will soon be throwing away twice as much refuse as each of us.

With increasing technology and production, we have wiped out some forms of pollution, only to produce other new and perhaps even more dangerous forms. Despite the celebrated alleged smoke clean-ups in cities like Pittsburgh and St. Louis, the air of urban America is more dangerous today than ever before. It may not be as visible, but our polluted air today is a greater hazard to health and a greater destroyer of property.

American cities are now spending something like 3 billion dollars a year for solid waste disposal. Three-quarters of that 3 billion dollars is for collection and transportation. About half the amount is spent by government and half by industry.

On a comparative scale, our cities spend more to get rid of our refuse (inadequately) than for almost any other activity to improve our municipal lives. We spend more for solid waste disposal than for police and fire protection. The fact is, that we have permitted our economy to burgeon into an engine of self-destruction. While we sit idly by, our economy becomes a system of massive output with no thought given to the ultimate destination of that output; it is incomplete.

In building and in accounting for our economy, we pretend that we consume. In fact, in the words of most businessmen, accounting offices, cities, and even the national government, we are all "consumers." But we are not really "consumers" of anything. We are only users and changers. We use things for a while, we change some things into other things, we transform the goods of our society from desirable items into waste products, and then we forget about them. With the fiction that we are consumers, we carefully account for economic costs in extracting ores and fuels, in harvesting food and fiber, in manufacturing, in processing, and in distribution. But the fiction always disappears in reality. We spend billions of dollars on solid waste disposal and do it inadequately and inefficiently.

Yet we maintain the fiction in our accounting. Nobody figures the discard cost in the purchase price, and we all suffer for the failure. For our vast expenditure we are getting inadequate and improper waste disposal, filthy air, polluted water, rats and insects, depressed property and land values, dumps and disasters.

My testimony today is that of one Congressman who attempts to speak for New York City. But waste disposal and pollution are national urban problems. New York, as our major urban center, is our most polluted area. Nature gave the City all possible benefits of clean air and water: open spaces and winds; massive rivers; the Atlantic Ocean. Man has given the area almost all possible pollution: increasingly intolerable air; unusable water; one of the world's largest gatherings of vermin. So the failures and achievements in New York City are bound to be indications of failures and achievements in our national attack on the problem.

Let's look at New York City's solid waste disposal problem. Every day New York must dispose of 32 million pounds of garbage and refuse. Of this:

75 percent is paper and paper derivatives;
10 percent is garbage;
8 to 10 percent is metal, plastic, glass and other noncombustible material;
2 to 3 percent is demolition debris.

The City disposes of this in three major ways: (1) about 35 percent is buried in landfills near incinerators; (2) something like 25 percent is buried in marine landfills on Staten Island; (3) about 40 percent is incinerated.

None of these methods as now practiced is very satisfactory for the citizens of New York. The landfills are very unsatisfactory. On January 1, 1966, the City Council banned open burning. The City had to shut down 5 open-burning pits at landfill sites.

When these fires went out, the bulk debris that had been burned was added to the landfills. The City's so-called "sanitary" landfills are breeding grounds for rats and other vermin which directly endanger the people's health and welfare just as air pollution does.

Incineration in New York City is equally, or even more, unsatisfactory. First, 100 pounds of refuse leaves something like 20 pounds of residue for landfill or other disposal. Second, incinerated refuse pollutes the air. Every day, New York City's municipal incinerators pour nearly 40 tons of particulate matter into the air. Much of it settles on the citizens, on their homes, in their windows and into their lungs. The incineration also pours an unknown amount of noxious and toxic gases into the air. Municipal incineration contributes most to the City's air pollution from solid waste disposal. The 11 major municipal incinerators are still without air pollution control equipment. Then there are some 18,000 smaller incinerators in apartment houses and other buildings which contribute a substantial or lesser amount to the air pollution problem.

Air pollution nationally has been estimated to cost something like 11 billion dollars a year—just about the same annual volume as our packaging industry. Air pollution is causing an estimated loss in property damage to New Yorkers of some 500 million dollars a year; not to mention the loss that each New Yorker suffers in life expectancy and health.

So, in the nation as in New York City, we have what can be mildly called a disaster in solid waste disposal.

The Federal Government and our local governments are failing to respond adequately to the disaster. The Federal Government has taken a first step forward in the Solid Waste Disposal Act, which was watered down and then overwhelmingly approved by both Houses of Congress in 1965. Despite the inadequacies of the Act, many members of the House and the Senate felt that even the minor achievements in that bill were too much. Seven members of the House Committee on Interstate and Foreign Commerce, for example, signed a minority report urging Congress to reject any and all proposals having to do with solid waste disposal. They said in their report "No case has been made for Federal action or the expenditure of funds in this field." I hereby invite them and representatives of similar points of view to come and stand with me on the east bank of the Hudson River and breathe deeply. And they will breathe the results of another State's solid waste disposal as yet unregulated by the Federal Government.

I invite them to go rat-chasing at any landfill or to dip into the Hudson River and drink their fill of its unregulated, interstate waters.

Obviously there are many Representatives, like myself, who feel that the Solid Waste Disposal Act is not even an adequate first step. The Act provides for a program of research and development, demonstration of new and improved technology, surveys, planning, and training. All of these are important, but they are hardly enough in the face of the disaster which faces us. One of the major failures of the Act, for instance, is that it provides no funds to help localities in the acquisition and construction of solid waste disposal facilities. The original bill called for 100 million dollars a year for three years to aid communities and states in acquiring facilities. The Department of Health, Education, and Welfare opposed the construction grant program on what I feel are specious grounds. The Department said new technology would have to be developed and tested.

It has been said that solid waste technology lags ten years behind technology in air pollution and 20 years behind technology in water pollution. That may be true, but to use these failures as justification for not catching up with the technology that does exist is nonsense. The Federal Government has been investing in air pollution technology for at least 11 years. The Public Health Service has been studying control of air pollution from refuse incinerators for years. Reams of data have been developed, but data compilation isn't action.

Incinerators remain the most flagrant municipal polluters; although we may be improving technology, air pollution itself is getting worse.

Under the Solid Waste Disposal Act, the Office of Solid Wastes has under way its own research program, totalling about 12 million dollars. The program is aimed at finding and evaluating better methods of getting rid of solid wastes. But regardless of the achievements of this research program, our technology today in solid waste disposal is far ahead of our action. In the face of modern disaster we need action and not delay.

Incinerators wear out. Urbanization continues. We can eliminate open burning. We can rehabilitate existing incinerators to include long-proved electrostatic precipitators for stack gases. We can install European-type sealed furnaces and waste boilers. We can install new crushers and shredders for raw waste materials. We can develop Federal standards. We can find ways to induce industry to cut down on waste material in packaging and consumer goods. With transportation costs increasing rapidly, we can seek new ways to collect and transport refuse. We can look to new ways to dispose of the residue of "waste from waste disposal." We can look to development of the whole concept of salvage and recycling.

Our technology is far more advanced than our installations, but we are literally facing disaster. We are getting killed and our country is being debilitated. With that situation before us, it is "bureaucratic hot air" to say we shouldn't spend more money on installations until our technology advances even further.

The Solid Waste Disposal Act has other failures. It does not provide for Federal standards or for Federal action to ensure compliance. It offers no effective enforcement means for dealing with interstate solid waste problems. It fails to incorporate many proposed and proved methods for engendering efficient disposal. (For instance, quite a number of members of the House have introduced bills setting up systems of tax incentives to engender greater investment in facilities.) In sum, the Act is merely a tentative first step.

Now let's look at our urban areas and our city administrations, which are failing even more drastically. Despite 30 years of the Interstate Sanitation Commission of New York and New Jersey, the State of New Jersey continues to send a good portion of its residue to New York. Inefficient "teepee-type" trash burners are still in use on the New Jersey meadows. New York and New Jersey have done little or nothing about this. In New York City itself, the administration had contributed more hot air than action. The need, of course, is for action.

Our municipal incinerators are the major source of pollution from solid waste disposal. They are pouring their filth every day into the air and into New Yorkers' lungs. While they are doing this, the City's Department of Sanitation is making a pilot study of air pollution control. Yet most of the things the study will explore are already known—as, for example, that it will cost some 20 million dollars to bring the incinerators into compliance with the City's own code as it now exists.

That's a lot of money. But if we keep our national and municipal accounts a little more realistically, we will see that it is not much money at all. In fact, for New Yorkers it would be far, far cheaper to fix the incinerators than to continue polluting the air, damaging property and endangering health. As I have said, air pollution is damaging New York property to the tune of 500 million dollars a year, roughly 25 times as much as it would cost to clean up a major source of this pollution i.e., the City's own incinerators.

One reputable study has shown that a family of four may be spending as much as $300 more each year to live in a dirty city than it would if the city were clean. Even a low income family may be spending $250 more. These increased costs include home maintenance, cleaning of clothing and other factors. For an expenditure of 2 to 3 dollars per person in New York we would eliminate 90 percent of the 38.6 tons a day of particulate pollution poured into the air by the municipal incinerators.

Early this year the New York City Administration set up its own task force on air pollution. On May 10, the task force submitted a thorough and comprehensive report. With much fanfare, the City poured out press releases.

Let me give you a few examples of the Report's recommendations and then raise a few questions.

After listing its recommendations, the task force noted, "A majority of the foregoing recommendations can be put into effect without legislative action." Then the task force went further and reported that it identified the city government itself as the worst violator of its own laws against air pollution. The task force sees unmistakable elements of hypocrisy in the attempt of the city government to enforce laws against others while continuing to break the law itself, in the operation of its incinerator plants and its bus transportation system, to mention only two sources of gross violation.

The task force found "not a single one of these municipal incinerators is at present equipped with a modern antipollution device." And it recommended the installation of effective equipment and upgrading to meet the optimum in current technology for particulate matter control in refuse burning.

The task force recommended immediate establishment of a network of both stationary and mobile monitoring stations using telemetering and systematic processing of air quality data.

Which of these recommendations of its own task force has New York activated over the last seven months? Despite the promises, what has been accomplished? Has the city continued its hypocrisy as charged by its own task force? Has the city carried out the recommendation to wipe out municipal incinerator pollution, or does it continue to violate its own laws? Has it, as recommended, set up a monitoring network? Has it, as recommended, wiped out pollution from bus transportation systems? Has it tested pollution control devices for its own 11,000 vehicles?

The answer, of course, is that there have been words, but no action. Yet, if we are to meet the threatened disaster of waste disposal and air pollution, we must have real action on the Federal level and on the local level. We must move from talk, promises, and pledges, to hard work and action. We must move from fun and failure to action and achievement.

The fact is that our failures in disposal of solid wastes and in pollution control are not failures in abilities or in technology. As a society we are rich enough. We have the money; we have the technology. According to various indications, most of the people of the United States see and understand the problems and the need. A Gallup poll published only last month indicated that the people are ready for action. Rather, the local failure is the failure of leadership, an unwillingness to offend vested interests like Consolidated Edison. It is a failure in ability to administer and it is a failure of decision and drive.

The Federal Government can do much to change these situations, not only in legislative, but also in administrative, action.

In 1962, the Surgeon General of the U.S. Public Health Service issued a report entitled "Motor Vehicles, Air Pollution and Health." At that time there were no Federal laws over automotive air pollution. The report was scorned by the automobile industry, but the people of the United States and then the Congress began to look hard and to understand the problem. The results you know. Let us hope that the same thing is starting to happen in our attack on solid waste disposal.

In conceptual terms, we must begin to look beyond solid waste disposal to the total cycling of our productive economy—from raw materials to production, to marketing, to use, and to disposal. We must begin to include on every price tag the final cost of salvage or disposal. We must seriously examine whether our present expenditure of some 11 billion dollars a year for fancy and convenient packaging is all good for our society and for our future.

If we counted the cost of disposal, we would realize there is no such thing as a "throw away." If automobiles, refrigerators, and every other item had a disposal cost in the original price tag, we might look to a little less planned obsolescence and a little more recycling.

In terms of wastes and recycling, and particularly in terms of new products, the Federal Government must begin to play an active role. It must stimulate and perhaps even require industry to cut down on the amount of waste passed on to the so-called "consumer."

Although salvaging of metals, rubber, and other materials is a multibillion dollar annual business, it recovers only a small portion of the potential recoverable wastes. Plastics are one of the fastest growing of our waste products. They are also one of the most difficult to dispose of. Yet plastics, like many other wastes, yield themselves to recycling.

The reusable milk bottle and the paper milk carton are gradually being replaced by a nonreusable and largely nondisposable plastic container. These polyethylene containers cannot be safely and efficiently burned in present day incinerators. They will not deteriorate by biological processes. You can bury one and dig it up substantially intact 50 years from now. It is technically difficult to shred or crush them for sanitary landfills. Thus, this one unregulated shift in packaging of one basic commodity is going to add a fantastic burden to our disposal disaster.

The recycling concept may be the only practical, long range approach to the problem. But to avoid an immediate disaster we need a much-improved solid waste disposal act. The Act should be amended to provide:

1. Federal financial support to municipal agencies for the construction of efficient solid waste disposal facilities.

2. Financial support for the development and maintenance of effective State and local solid waste management programs. The Act should require that State and local programs be coordinated in regional approaches.

3. A system of incentives and controls to ensure industry will cut down excess waste in packaging and finished products. The Federal Government must have the authority to engender or prohibit various packaging practices.

As a start, funds in the order of at least 200 million dollars a year must be authorized for construction grants. We must have an enormous increase in research allocations.

However, action on the Federal level is only a part of the problem. Our local administrations and our cities must begin to stop talking and to start acting. The tide of national sentiment is running high about problems of the human environment. People realize that there is absolutely no reason why they cannot have clean water to drink and clean air to breathe. There is absolutely no reason why the richest society in the world cannot provide a decent and clean environment. And people know that our failures are not in riches or in technology or in time. Our only failure is our failure of will, of decision, of leadership and administration.

If we are to meet the disposal disaster, the day has come when we must write a new commandment for our modern industrial society. We must write an 11th commandment, "Thou Shalt Not Pollute." And we must enforce it, whatever the cost, whatever the vested interests, whatever the administrative problems.

QUESTIONS AND COMMENTS

MIRO DVIRKA (*Chief Engineer, Morse Boulger Division, Hagan Industries, Corona, New York*): I want to comment on the paper by Mr. Fife on "Control of Air Pollution from Municipal Incinerators." I agree 100 percent with the paper presented by Mr. Rehm. Mr. Fife made a remarkably sharp distinction between batch-fed furnaces and continuous-feed furnaces. Without elaborating too much on this, I think there is a lot more to it than just the distinction between a batch-fed and a continuously-fed furnace. I could show Mr. Fife quite a few batch-fed furnaces which would make a continuous-feed furnace in some instances look like an antiquated fireplace. As for the comparative efficiency of settling chambers and spray chambers, a dry settling or separation chamber can be designed not only to meet present ASME requirements but also to exceed them.

Tests have been conducted on large and small furnaces which would show that a dry separation chamber can reduce solid emissions down to .4 or .5 lbs. per 1000 lbs. flue gas, corrected to 50 percent excess air. The question is the design. As for wet chambers or spray chambers or gas scrubbers—actually the difference between spray chambers and spray gas washers becomes very slight if just the static pressure drop through these chambers is changed—solid emissions have been demonstrated to be far in excess of what Mr. Fife indicated, such as .8 or .6 lbs. per 1000 lbs. of flue gas, corrected to 50 percent excess air. Spray chambers or gas washers of relatively low cost have been developed which can reduce without any major problem the solid emissions to .2 or .25 lbs. per 1000 lbs. of flue gas, corrected to 50 percent excess air. I'm reasonably sure that further reduction can be accomplished just by increasing static pressure, which confirms what Mr. Rehm was saying in his paper.

Instead of looking into these designs, many people went to Europe, looking for some magic formulas on reducing air pollution by European systems. After hearing for about a year of a European system, I went to Europe myself and I have to say that the chimneys there were quite clean, much cleaner than we see here, because of electrostatic precipitators. But one thing I was led to believe, I actually found: if these plants had had devices other than electrostatic precipitators, they would be polluting the air much more than the American plant. In other words, whatever sins have been committed in the European plants in the combustion process, such as air distribution, complete combustion of gases in the final and secondary chambers, etc., have been covered up by the electrostatic precipitators. This is also confirmed by tests. The quality of fly ash and carbon-containing particles in the electrostatic precipitators is such that if a device were used like a U.S. spray chamber, these plants would probably be polluting half of Europe.

FIFE: I tried to make clear in my discussion, and I think Fred Rehm did also, that the efficiency of these baffle spray chambers is directly proportional to the pressure drop that's involved. Mr. Dvirka would agree with that, I believe. The point I'm trying to make is that the reason you put a batch-fed system in is that you want a simple system for a particular application. As your pressure-drop requirements increase, immediately you must depart from your basic intent to provide a simple system.

You get an induced-draft fan with this increased pressure drop and of course the pressure-drop requirement was generated by the desire to have a clean gas stream. So we have to keep our priorities clear here and we also have to appreciate that it is possible to improve our gas cleaning with spray systems. The point I want to emphasize is that, with a system designed to be simple in the first place, we do have this limit of about .85 from our own experience and test results.

GODER: Continuous charging of multiple-chamber incinerators is practiced in Los Angeles County, the Bay area, and other air pollution areas without nuisance. Have you determined, Mr. Jackson, by tests, that this is impossible?

JACKSON: I'm not sure I understand the question. By continuous feeding, I assume you mean intermittent charging of the unit during the burning period. This is a common practice with the batch-type incinerators that we see in the northeastern United States, the Philadelphia area, for instance. We're talking about a different design when we get to the West Coast, the Los Angeles area, a different type of basic unit usually. It is not impossible to charge a unit of the type we're familiar with intermittently without creating a nuisance, but it's close to impossible. This charging while there is burning ash or refuse on the grate causes visible fly ash emissions. This, in my opinion is not consistent with the design of some types of incinerators. They are not made to provide proper combustion under these adverse operating conditions.

JAMES B. FEUSS (*Director of Air Pollution Control, City of East Orange, New Jersey*): At peak burning rates in the batch-operated apartment-house-type incinerator, the emissions are often a neighborhood nuisance if not a major source of particulates. Mr. Voelker, is there any information available which shows any relation between peak emission at peak burning rate and the grate loading? The recommended grate loadings differ considerably from other standards or criteria.

VOELKER: This is rather involved. We have to start by defining what type of apartment-house incinerators we're discussing. There are a number of types, the old famous one being the single-chamber, single-chute, which also acted as a stack. We have a more modern design with a three-chamber unit and a single stack conducted by a bypass up to possibly the first or second floor. We have a more modern incinerator which is a unit, with its own stack and a separate chute for the charging of the refuse from the various floors. Before I can answer that question, I'd like to have a definition as to what type incinerator Mr. Feuss is talking about.

FEUSS: I'm talking about type II–A incinerators and the recommended grate loading for them, comparing them with the design recommended by Los Angeles and New York. Expressing the grate loadings in terms of burning rate, either by pounds per hour versus grate loading in pounds per square foot per hour, or expressing it in BTU's per hour and BTU's per square foot per hour, there seems to be a greater than tenfold difference between the various recommendations for grate loadings. It is very disturbing to an amateur like me to start out by finding evidence that in incinerator design there is a relationship between particulate emissions and grate loading, and then to learn later that the standards we're puzzled with have a variation greater than tenfold in grate loadings, regardless of how you express them.

VOELKER: I have not made a direct comparison between the various grate loadings that you speak of, and there has probably been insufficient testing performed to provide a clear relationship between grate loading and particulate emission. This applies particularly to the apartment-house incinerator. There just are not sufficient data available at the present time.

GEORGE ARNOLD, Sc. D. (*Chief of Technical Service, Air Conservation Commission, Jefferson City, Missouri*): Like Mr. Voelker of the Incinerator Institute of America, control agencies recognize a need for standardized terms and procedures. We need to select, for instance, one way of expressing emission rate instead of considering numerous alternative ways like micrograms of particulate per cubic meter or pounds per 1,000 pounds or grains per standard cubic foot. We should find complete agreement even on what constitutes a standard cubic foot. Also, we need a standard way of rating incinerators according to their capacity.

I ask respectfully, who is in better position to do this than the Incinerator Institute of America itself? Why don't the members get together and really agree on standards and make a firm recommendation then to other people who are involved with this subject. I ask the simple question, what is the II–A waiting for at this stage? Is it waiting for some university to set the values or waiting for the Federal Government to do it? Whom are we waiting for? As an air pollution control agent for the State of Missouri, I would personally have hesitation in declaring what these standards for incinerator performance ought to be. I'm not a specialist in combustion or in pyrology. I would write incinerator standards with great reluctance. I request II–A to supply them; otherwise, it may be necessary for me to do it, however inexperienced I am.

LEO FLOOD (*New York City Department of Air Pollution Control*): My title is Senior Engineering Advisor, but I came up here as Chairman of the task force of the American Society of Mechanical Engineers, which is now working on the emission standards for incinerators. By the way, Mr. Voelker is a member of this task force also. We expect to have all of these things that have been asked for, complete test procedures, for instance, a glossary of terms, conversion tables from one unit to another, and an emission standard which we can recommend. We are aiming to have these submitted to the main committee, ASME Standards Committee, some time in the middle of next year. So there is something in the future to look forward to.

WILLIAM M. HARRINGTON, Jr. (*Project Engineer, Whitman, Requardt and Associates, Baltimore*): In proposing extensive use of on-site incineration for the volumetric reduction of refuse, what is the incinerator industry doing to upgrade the level of efficiency of the various small incinerator operators?

VOELKER: There is no extensive program in force. I think the legitimate incinerator manufacturers and installers tend to do a certain amount of education on operation after they have made the installation. Our biggest problem, however, is that the operators are a floating type of manpower. I know that I have made repeated visits to many installations and never encountered the same operator twice, even within the same week. So this education program is something that is very difficult to undertake.

FOX: This is why some of the speakers today have urged greater use of mechanized equipment.

It seems to Professor Gorder of the University of Wisconsin that this session on solid waste disposal has placed the theme of the conference, air pollution, second to that of the most efficient method of waste disposal. Yet it was individual industries and municipalities, following methods of maximum efficiency and least cost, which brought about the present state of air pollution. This session has concentrated on incineration as a practical low-cost disposal method and on more efficient methods of incineration.

Of all the methods of waste disposal, incineration contributes most to air pollution and this is true even of the hypothetically perfect incinerator that gives off nothing but water vapor and CO_2. How much CO_2 can we put into the atmosphere from all sources? And how much of other gases resulting from combustion should an unproductive source such as incineration be permitted? As I understand it, Professor Gorder is saying that we're putting CO_2 into the atmosphere by this means and CO_2 is a pollutant. This is an unproductive way when we incinerate waste. How much can we afford to do with this kind of thing? Have I got you right?

LYLE GORDER (*Professor of Geography, University of Wisconsin, Manitowoc*): Right. I'm afraid I'm not going to make any friends among the engineers here because I'm a generalist and not a specialist. The speeches yesterday made a lot of sense to me. I believe Dr. Stead from Berkeley also made a lot of sense and Congressman Ryan made a lot of sense, but everyone else sounded to me very much like a group of admirals in the early part of the Second World War who might have got together to push for better battleships. The object at the time was winning the war. Insofar as these battleships might be the shortest route toward winning the war, it was the correct objective. But this was not the shortest route to winning the war, and soon after the new battleships were built, they were put in mothballs. If we had not picked the apples, oranges, grapefruit, etc., that we're putting in incinerators—and this also applies to wood, paper, and everything else—they would have become part of the soil anyway. That is what soil is. Why do we have to burn this stuff and breathe it first? I think we can prove this will ultimately end up in the soil anyway. I was wondering if this idea of better and better incineration is really meeting the objective of less air pollution. I believe that composting is. I think the real problem is to get the cost of composting down to a price that the consumer is willing to pay.

McGAUGHEY: Being one of those who did a lot of work originally on composting, I'm not in a position to oppose anyone who applauds it. I would like to say, though, in response to Professor Gorder, that we are confronted in our solid waste with material that is about 50 percent noncompostable. Plastics are comprising more and more of our solid wastes. So we're ending up, whether we incinerate or compost, with a decreasing proportion of the total that is reclaimable by any means whatsoever. I certainly agree that wastes are headed back to the earth if they are organic matter to begin with.

". . . engineer . . . past president, Incinerator Institute of America . . . for four years chairman of APCA's incinerator committee . . ."

CONCLUDING REMARKS

RICHARD GODER
President, Joseph Goder Incinerators
Elk Grove Village, Illinois

Solid waste evidently is a portion of solid waste management and this involves the selection of the most appropriate method or methods of disposal for each specific case or area. Today we seem to have become an incinerator symposium. Apparently the incinerator has its place in solid waste disposal.

Air pollution is to some extent inherent in almost every method of solid waste disposal, so a consideration must be given to air pollution control. There is no air-pollution-free method. As cited by Michaels, air pollution is derived 1 percent from good incinerators, 2.5 percent from poor incinerators, and 35 percent from open burning. The contribution of incineration to air pollution is relatively small.

We must also consider the effect of air pollution as far as public health disasters, transportation shutdowns, property damage, and chronic health impairment are concerned. In these, refuse disposal plays a relatively unimportant part. As far as human comfort is concerned, refuse disposal plays a more important part.

Each disposal method, whether it is by liquid waste treatment or sanitary landfill or incinerator, can interfere with human comfort.

Then there is an effect of air pollution on scenic value. This can be very importent. It is something that we are going to have to decide ultimately. The goal of sparkling clear air may be achieved since technology is moving forward. Presently a new method should bring this about.

Solid waste disposal incorporates many things. It incorporates air pollution, water pollution and natural resource dissipation, as well as land use. Most of the speakers agreed that these are all related and that each area should study its particular problem.

We had some question on the definition of waste. What was yesterday's waste may be tomorrow's raw material for energy. The energy contained in the combustible material that is disposed of might be a fuel resource.

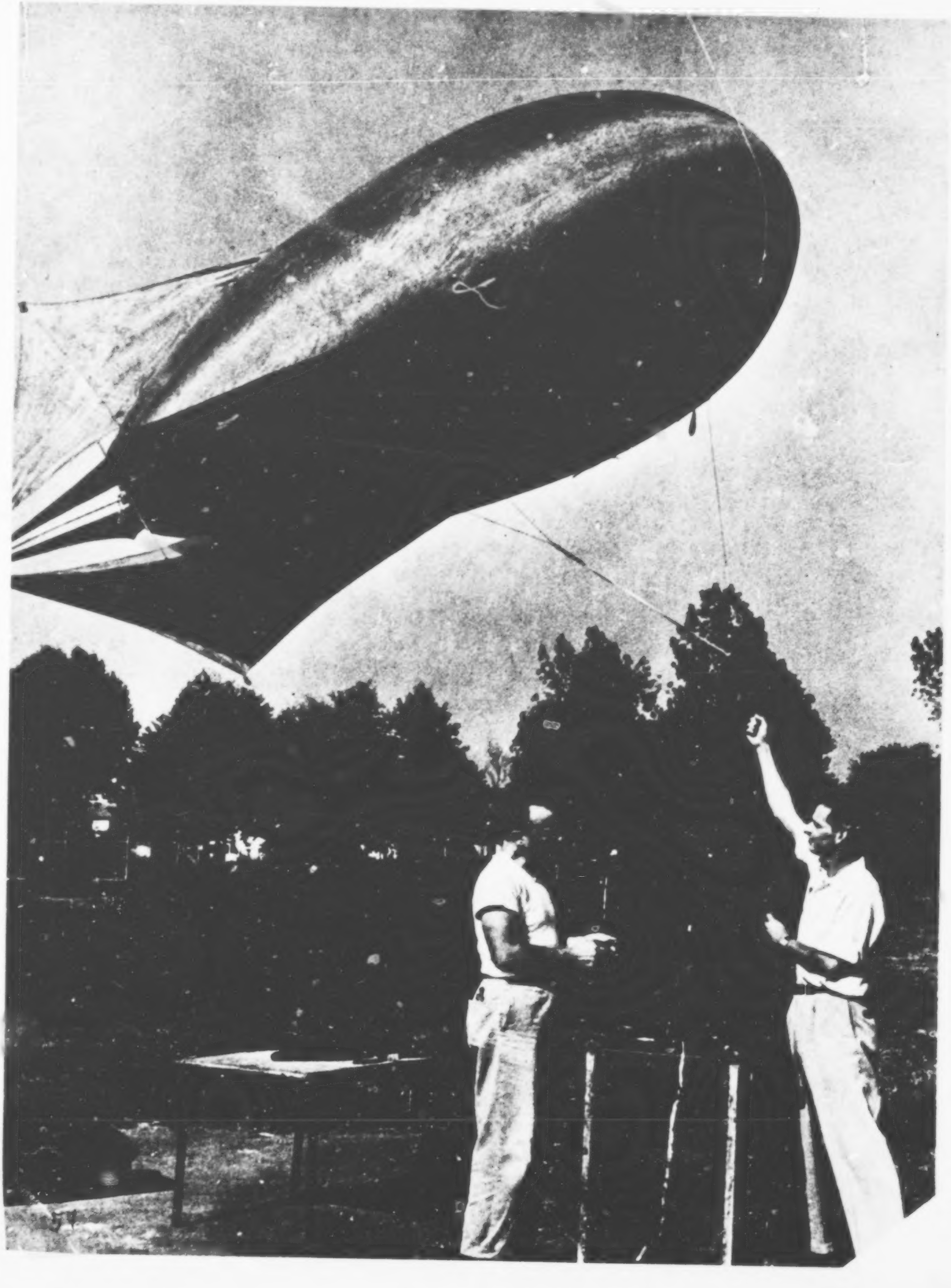
Incinerators bore the brunt of our discussion, not only municipal incinerators (although they carried most of the attention), but also other types. It was demonstrated that municipal incinerators can be developed to the point where particulate discharge of .035 lb. per 1000 lb. of flue gas corrected to 50 percent excess air is achieved, producing, for all purposes, an invisible discharge.

The public sees not only the overall problem of air pollution, but primarily the nuisance problem. The visible problem of smoke, particularly in the commercial and industrial areas, and the problem of visible particulates must also be dealt with. Technology is sufficiently advanced to control this, but there is still a problem in the operation of the incinerators once we build them.

The cost of improvement on incinerators is rather interesting. Although the contribution to overall air pollution is relatively small, the cost of improvement is very large. It doubles the cost of an incinerator to effect a 50 percent improvement over present industry standards. This is out of proportion. For more than a 50 percent improvement in automobile emissions the average citizen has only to pay a fraction of 1 percent.

Incineration on the site is economical. Not only does it eliminate the nuisances of air pollution and the many other accompanying nuisances which concern us, but it saves very heavy costs of hauling and incinerating at a central site.

Finally, there is a great deal of antiquated incinerator equipment which was built when there was a laxity in control. This equipment, unfortunately, was built to last. This, it seems to me, is one of the most serious problems we have.



STATE LINE
E

December 13, 1966

PANEL E

STATE AND INTERSTATE AIR POLLUTION CONTROL PROGRAMS

Chairman Alfred L. Frechette
Commissioner of Public Health
Massachusetts Department
of Public Health
Boston, Massachusetts

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". . . physician and public health officer . . . former chief of UNRRA mission to Ethiopia . . . former Harvard professor of public health . . . past president of Massachusetts Public Health Association . . ."

STATUS REPORT

ALFRED L. FRECHETTE, M.D.
State Commissioner of
Public Health
Boston, Massachusetts

You will hear, in the course of this morning's discussion, presentations which are intended to emphasize and support the essential role of the State in air pollution control programs. Concurrently, attendees at Panels F and G are hearing similar presentations with respect to local, regional, and Federal programs. This afternoon we will meet jointly with Panel F to discuss some aspects of the interrelationships of these programs. I hope that as a result of our discussions we can point the way toward the most effective, most productive, most economic programs at the several levels of government, along with the necessary actions of industry and the general public.

I would now like to introduce and discuss briefly the term "air use management" as it may be compared to air pollution control or air resource management programs. I believe a good air use management program at any level of government must maintain a proper balance between those efforts directed toward air pollution control, air pollution abatement, or air pollution prevention, and those efforts directed towards reasonable and maximum use of our air as a resource in a manner compatible with its capability to receive and disperse wastes resulting from man's individual and collective activities.

Preservation of absolute purity of air in certain places where it is of no useful service to man or to those elements in the environment upon which man depends, is *per se* a waste of a valuable resource. Paradoxical as it may seem, air is a resource only if used; it cannot be hoarded. As the drop of rain which falls on land, then runs downhill into a river and goes back unused to the ocean, is lost for use as fresh water until it returns as an entirely new drop of rain in nature's cycle, so, in the same way, air is wasted if it is not used. Air exists as a resource because of its life-supporting properties and through its capability to receive a limited amount of dirt, and then, by means of natural phenomena, to cleanse itself. The phenomenon of self-purification is truly part of the resource. Our objective must be prudent use of this phenomenon without overtaxing its capability, while at the same time maintaining an air quality satisfactory to a democratic society. This is one reason why such programs as we are discussing here today belong, in my opinion, in the realm of *air use management*, rather than in the realm of *air pollution control.*

We must, while managing the air use, also be custodians of the ambient air space. We must monitor and inventory its corruption by man's input of gases and particles of significance, whether in minute or in gross amounts. We must evaluate the effect of, and regulate, in addition, such other phenomena as noise and ionizing radiation. More generally, we must exercise prudent management of the air for breathing, for supporting other forms of life, for providing oxygen for combustion, and for transporting certain of our wastes from their points of generation to their points of ultimate disposal in a balanced system. I suggest that the phrase "air use management" comes closest to including all of the necessary viewpoints, needs, and activities which must be accommodated.

I believe that the 50 States must exert a dominant influence in such programs. The State governments are fundamentally responsible for the protection of the health, comfort, and convenience of their citizens and for husbanding their economic resources. It is the responsibility of the States to guard the health of their citizens against polluted air by preventing deterioration of the air's quality to an undersirable degree through improper use of the air, and at the same time to ensure that, insofar as is practical, the use of the air is not denied to the industrial and commercial community upon which the economic welfare of the citizenry is so dependent.

There are, of course, many ways in which these responsibilities may be exercised, and different ways may be fitting for different circumstances and for different States. To cite extremes, the State of Rhode Island has problems which differ from those of the State of New York. The State of Hawaii is like no other. Therefore, it seems apparent that there must be different approaches to the fulfilling of the same general responsibilities, State by State, within the general constraints of legal, administrative, and technical feasibilities.

Certainly, the State has the authority to exercise direct control over use of the air through imposition of emission control, zoning controls, and the like. It may find that some minimum protection for all its inhabitants is required at the State level; or it may find that this protection can better be provided by, or in concert with, the guidance and development of local and regional programs.

The ambient air space over the geographical limits of the States represents resource capabilities which are different for each State. The resource varies from State to State, in its volume, its climate, its meteorological patterns, its geographical location, and the airsheds from which it derives. These variations determine the relative values to the individual States or "their ambient air heritage" and the uses to which it can be put under balanced air use management programs. The ambient air over a State is therefore a resource which varies from State to State in its value just as much as mineral, land, water, or other resources vary. It is a resource which a State has a right to zealously guard, protect, and use competitively with other States to its own advantage, as in the case of oil, coal, and mineral resources. It has a right to receive air from the airshed over adjacent States in reasonably good quality, and, likewise, it has an obligation to discharge air across its boundaries to sister States in reasonably good quality. However, a State's particular geographic location (e.g., adjacent to an ocean or large body of water, as in the case of Hawaii) may give it apparent advantages and greater latitude in its air use management program.

The Federal Government is quite obviously occupying a very significant place in the air use management picture and will continue to do so. It is the responsibility of the States to cooperate with the Federal program, but at the same time to strive to guide the Federal program so as to best serve the States and their people. The possible harm of conflicting rules must be avoided in the interest of the much greater good that can come from cooperating activities. My thesis, and I hope, that of my fellow panelists, is that the States must exercise a dominant role in air use management programs. This role must lie principally in the area of execution of programs developed in substantial measure by the States and their communities, with assistance and guidance provided by the Federal Government. There are, of course, obvious exceptions to this, where the Federal Government, because of the nature of the problem, assumes the dominant role to execution. But if the States are alert and responsive to their responsibilities, it should be their collective guidance which causes the Federal Government to initiate, develop, and execute programs.

I believe most observers will assign to the Federal Government the primary responsibility for research, for investigations into problems of a general nature, for development of knowledge regarding effects, and for the establishment of criteria for air quality standards. On the other hand, the establishment of the enforceable standards, or most of them, is properly an item for the States or communities.

The States have substantial problems to overcome if they are to act as I envision they should. The crux of the matter is money. How can the States share in the greater financial resources of the Federal Government and still maintain their independence and retain the primary responsibility in air use management? One way is suggested in the "Declaration of Purpose" in the new Comprehensive Health Planning and Public Health Services amendments of 1966 (PL 89–749), which states a principle of Federal-State collaboration that is new in the health field:

> "The Congress declares that fulfillment of our national purpose depends on promoting and assuring the highest level of health attainable for every person, in an environment which contributes positively to healthful individual and family living; . . . that attainment of this goal depends on an effective partnership, involving close intergovernmental collaboration . . . and that financial assistance must be directed to support the marshaling of all health resources—national, State, and local . . ."

The key concepts here are (1) partnership, and (2) the acknowledged need to use Federal funds to support the State and local health programs.

As important as the problem of money is that of personnel. There are simply not enough brains and bodies to go around. This problem must be met and initially solved by a substantial Federally-directed and supported training effort; but the States in their personnel practices and policies must establish sufficient flexibility to attract and accept qualified personnel for the needs at hand, wherever the source of the personnel may be, and to maintain themselves competitive with other seekers of talent. The States, individually and collectively, must embrace the concept of some degree of uniformity as desirable, recognizing, as mentioned before, that differences must and will exist. Each State must define its own problems and its own needs and must develop its own programs based on these problems and guided by yet-to-be-developed criteria and economic guidelines. It is up to the States, with Federal assistance and guidance, to develop and encourage public acceptance of what is good for people, acceptance of the fact that controls must be instituted over their daily lives, and that this is going to cost them money. In the development of public acceptance, it seems certain that the public must have a voice in the decisions. How this voice can best be raised and heard has yet to be developed.

Perhaps certain trends toward what many consider a constructive Federalism and others view as a destructive Federalism have progressed too far to be reversed; we must develop our essential roles and programs in the light of the status quo. Certainly strong, growing, adaptive, and innovative State programs are required to form a nucleus for related programs ranging from the local to the regional to the interstate. I hope that our deliberations here will show a path or alternate paths for us to follow, and establish some speed limits, or more appropriately, speed guides, by which to proceed.

". . . chemical engineering background . . . 34 years of public health experience in local, State, and Federal agencies . . ."

A ROLL CALL OF THE STATES—WHERE DO WE STAND IN STATE AND INTERSTATE AIR POLLUTION CONTROL?

CHARLES D. YAFFE
Chief, Control Agency Development Program, National Center for Air Pollution Control, U.S. Public Health Service Washington, D.C.

While I hesitate to infringe on the subject to be covered by the next speaker, as a preface to my own topic I, too, wish to make a case for State air pollution control programs.

State programs are needed for many reasons. Among these are:

(1) To provide pollution control in areas outside those which are under the jurisdiction of local or regional programs;

(2) to provide strength and support to local programs which lack the ability to correct problems by themselves;

(3) to step in and correct problems which local programs lack the will to correct;

(4) to assure that region-wide problems, particularly of an interstate character, will be corrected;

(5) to assure industry that some plants will not be put at a competitive disadvantage because of variation in standards between different areas of the State.

There are many other reasons which will certainly be brought out before the conclusion of this session, but I wish to make my support of State programs clear before proceeding with other remarks, which are not entirely laudatory.

The first legislation providing authority for air pollution control by a State agency was enacted just 15 years ago. Ten years ago a total of three such State laws were in effect. Five years later there were 13 with comprehensive air pollution control authority.

Excluding two which provided just limited coverage, State-wide control of air pollution was authorized in 14 States at the time the Clean Air Act was adopted in December 1963.

During the three years which have elapsed since that Act went into effect, 11 more State legislatures have passed laws providing mechanisms for control by State action, and earlier laws in several States have been strengthened by amendments.

A number of other States have legislation authorizing programs of research, technical assistance or other activities of a nonregulatory nature. These are not classified for the purposes of this discussion as having control programs. Many other legislatures will be considering air pollution control during the 1967 sessions and I predict that at least 10 will enact laws providing control authority at the State level during this coming year.

In terms of the number of State programs that can be reported, substantial progress has been made in a relatively short period. A survey of 1961 budgets for State air pollution programs, regardless of whether control authority was included, showed a national level of $2 million. The State of California accounted for 57 percent of this total, with New York and New Jersey the only others reporting budgets in excess of $100,000 at that time. Now, five years later, State appropriations for their pollution programs total $7.2 million; $2 million in Federal grants raised their combined budgets to $9.2 million. Eleven State budgets now exceed $100,000 per year.

In 1961 these agencies had 148 full-time and 29 part-time personnel. Although many vacancies exist due to a critical shortage of qualified individuals, there are known to be 406 full-time and 81 part-time positions currently budgeted for State programs.

While yet far from adequate in most instances, there has been a significant increase in resources being provided for State control activities, and these resources are being utilized not only to obtain more and better-trained personnel, but also for the acquisition of equipment and information needed for the proper definition of the problems involved.

It would be naive and erroneous, however, to conclude that mere application of increased resources will guarantee the disappearance of these problems. Success of programs to prevent and control air pollution requires soundly conceived authority and operational procedures, proper administration, together with sincere and clearly expressed support of appropriate policies by the executive, legislative and judicial arms of government.

Despite the time limitations this morning, it might be worthwhile to examine some of the aspects of the authority, operations and administration of the programs created by the legislatures of 25 States. Needless to say there is variety in their approaches.

In 9 States the responsibility and authority for air pollution control was given to existing agencies, 5 of them health departments and 4 of them commissions which are also responsible for water pollution control. In 13 instances new boards, commissions or similar authorities were created within health departments, and in 8 other cases independent agencies were established.

Even though, in most instances, administration and authority were assigned to others, in 18 States the health department has the responsibility of providing technical staff and services needed for conduct of the program. In seven cases the independent agencies have their own budgets and employ all of the personnel.

In all but five States the legislation establishes a board, commission or similar body and generally specifies the interests to be represented in its membership. In 19 instances, heads of one or more designated State agencies are included as ex-officio members. The health commissioner is included in each of these, with the laws sometimes assigning him the position of chairman. Other agency heads often designated for board membership include those concerned with commerce or industrial development, labor, conservation, agriculture and livestock.

Many laws specify that one or more board members be engineers, and similarly, that their membership include a physician. Most boards are required to have representation of the local governmental agencies. Likewise, where membership is specified, nearly every law provides for industrial representation. In a few instances, there are requirements that specific classes of industries be represented. Representation from labor or agriculture is also specified in several State laws. Many laws also provide for representation of the general public.

As a rule, the intent seems to be to include representation both from those interests affected by pollution and from those likely to be affected by any regulations.

On the other hand, one act, passed in 1966, has the refreshing—or at least novel—proviso that "no officer, employee or representative of any industry, county, city or town which may become subject to the rules and regulations of the board shall be appointed to the board."

In two instances the board served only as an advisory body.

In 20 States the board has powers to adopt and promulgate rules and regulations to enforce them. Two others establish the regulations, but leave the enforcement authority to the health department. In another, the board serves only as a variance board. In at least one State, regulations must be approved by the government; in another, by the legislature.

In most States, the board or commission has the power to hold hearings on alleged violations of regulations. In many instances board hearings are mandatory in every case. Where an active program is being conducted, this can present difficulties since it places excessive demands on the time of board members. Legislative amendments to alleviate this problem are being suggested in several States.

With minor variations, the procedures for developing and promulgating regulations are fairly similar in most States. The steps involved usually include drafting of proposed regulations by the agency staff, with either formal or informal assistance or review by outside technical experts or affected interests, and formal public hearings followed by official action by the board. While considerably more or slightly less time is consumed, the average time generally involved is reported to be about a year after action is initiated.

A survey which I have just completed shows, however, that some States are discouragingly slow in initiating action. Of the 14 States with comprehensive control authority authorized prior to the passage of the Clean Air Act, 6 have not yet adopted any regulation of any kind whatsoever. The other 8 took an average of approximately 3½ years to promulgate their first regulations. It should be noted also that in some instances several additional years are allowed before compliance with important provisions of the regulations is required.

Among 10 State programs established during the past 3 years, there is some slight evidence of a faster pace with respect to development of rules and regulations. Five States have adopted regulations or have regulations currently in the developmental process; the other 5 report no activity. In the eleventh recently created program, the legislature itself determines the standards, regulations to be applied to put them in the law. Thus about half of the States with comprehensive control authority have yet to adopt any regulations. Only a third of the States have adopted regulations to provide control over as elementary a problem as open burning.

Where orders to comply with regulations are ignored, the State control agency in 24 of the 25 States which have control authority is empowered to seek injunctive relief. Fines and/or jail sentences are likewise provided for, also in the 24 States. The maximum fines range from $10 to $3,000, with a median value of under $200. Each day of violation can usually be considered a separate offense. Many program administrators feel that the fines imposed do not serve to control significant pollution sources. Jailing, while seldom employed, is much more effective. The injunctive process undoubtedly provides the most positive means for achieving pollution control. However, with a few notable exceptions, State agencies seldom carry their actions to the court stage.

Most State laws specify that control officials and their employees may not disclose confidential information about industrial processes or operations. In some instances violations are classified as misdemeanors or felonies. In one State the penalty ranges from $200 to $5,000, or from 2 to 10 years imprisonment. It is interesting to note that, in this same State, the penalty for air pollution violations is $50.

I shall not attempt to review the variety of legal procedures involved in enforcement of orders by control agencies. It should be mentioned, however, that through legal processes in some States, while the pollution continues, it is possible to keep cases tied up for years.

There is great variety in State air pollution control laws with respect to the role and authority of local governments. In three instances no local programs are permitted. In a fourth State, the one local program in existence prior to adoption of the State law was permitted to continue, but no other was allowed. One State law ignores the subject entirely. While most State laws permit and encourage local programs, the language sometimes is vague, with the result that there are doubts concerning the authority and limits of jurisdiction of such programs. These difficulties arise particularly with respect to such questions as the ability of county agencies to enforce regulations in incorporated communities, and the legality of multijurisdictional agencies to enforce uniform standards throughout an area. The presence of these uncertainties results in delays in establishing control programs and hesitancy in testing authority.

The relationships of the State agency to local programs are not always clear. One recently passed State law calls for "independent and concurrent enforcement of both State and local regulations." Under this act it appears possible, at least theoretically, for three different agencies to have authority to simultaneously and separately enforce their own standards in the same community.

Many State laws say that local governments may pass ordinances with requirements not in conflict with those of the State. The intent presumably is to permit localities to assure themselves of such air quality as they desire, as long as the State standards are met. Yet a recent State court decision held that this "not in conflict" language prohibits localities from enforcing regulations more restrictive than those promulgated by the state board.

From this brief glimpse of some aspects of State air pollution legislation, it is obvious that a variety of approaches have been taken. This variety is not of itself undesirable, since the nature and extent of air pollution problems differ due to such variables as population in the area, topography, climate, urbanization and industrial development. What is regrettable, though understandable, however, is the poor quality of much of the legislation enacted.

In efforts to meet competition and attract customers, merchants offer many inducements, such as trading stamps which may be redeemed for a variety of items. These are listed in attractive catalogues. They range from bath towels to round-the-world vacation trips. State governments similarly compete to attract new people, commerce and industry. They likewise offer "trading stamps" redeemable for valuable prizes, which are described in their legislative catalogues. One prize which can, unfortunately, be found in a few of these catalogues is a license to pollute the atmosphere with relative impunity.

Let me quote an example from an act passed a few years ago: "It is the policy of this State to maintain such degree of purity of the air resources of the State as is technically feasible, economically reasonable, and necessary for the protection of health, general welfare and property of its people. The measures for the accomplishment of this purpose are not unreasonably to obstruct the operation and development of business and industry. Such purposes are at all times sought to be effectuated by conference, cooperation, and persuasion; provided, however, that powers and enforcement procedures here established may be exercised whenever further persuasion would be of no avail."

Language of this character is to be found in several State laws. It clearly proclaims all of the excuses needed to justify noncompliance with any significant requirement. Unsurprisingly, there is no demonstrable evidence that any air pollution has either been prevented or abated in most of these States, regardless of the time since the laws were enacted.

Some States have legislation of reasonably good quality and, in a few of these, where this is being supported with suitable financial and policy support, signs of noteworthy progress are beginning to appear. Other programs have yet to prove their worth. To give an example of inaction, during a recent visit to a State which has had control legislation for over five years, I was told that it was their policy to encourage formation of local programs. I asked rather casually whether countywide programs could be established and was told they didn't know. They had finally asked the attorney general for an opinion 18 months ago. They were still waiting for an answer. This agency has not yet started to develop its first regulation.

To summarize where we stand in State air pollution control, I would say in the terminology of the prizefight industry, some programs are actually in the ring, sparring with the opposition, throwing a few left jabs and occasionally counterpunching with a right. The greater number are still in the gym, shadowboxing, and too many have signed to fight, but have yet to start training, even though they are in no shape to fight.

According to the title assigned to this presentation, I am also supposed to review the status of interstate air pollution control. There is little to report yet in terms of formal actions by states except for the interstate compact between Illinois and Indiana. I assume this compact will be discussed by Dr. Bregman.

Recent amendments to the New York State Air Pollution Control law call for broadening of the scope of air pollution activities of the Interstate Sanitation Commission when similar authorization is adopted by New Jersey. Included would be participation by the Commission in Federal abatement conferences and in establishment of air pollution monitoring and warning systems. The Commission does not have enforcement powers. I know of no other formal mechanisms currently under development by States to control the interstate pollution.

The Department of Health, Education, and Welfare, under provisions of the Clean Air Act, is engaged in abatement activity in nine interstate air pollution situations in the following locations:

1. Selbyville, Delaware-Bishop, Maryland. This was initiated at State request.
2. Shoreham, Vermont-Ticonderoga, New York; initiated at State request.
3. New York metropolitan area, including 8 counties in New York and 9 counties in New Jersey, initiated at State request and expanded by the Secretary.
4. Clarkston, Washington-Lewiston, Idaho.
5. Steubenville, Ohio-Weirton and Wheeling, West Virginia.
6. Kansas City, Missouri-Kansas.
7. Harpersburg, West Virginia-Marietta, Ohio.
8. Ironton, Ohio-Huntington, West Virginia-Ashland, Kentucky.
9. District of Columbia-Maryland-Virginia.

Hopefully, out of these actions some continuing mechanism for interstate pollution control will evolve.

In conclusion, I believe every State should have an air pollution control agency with the necessary authority, resources, and capabilities to ensure that all air pollution problems which need correction can and will be appropriately dealt with. Legislation in each State should clearly spell out the authorities, responsibilities and roles of State and local governments and should be designed to assure that suitable mechanisms for the control of air pollution on a regional basis where needed will be provided. The legislation should be designed to ensure orderly, equitable, efficient administration of its provisions.

Encouraging progress is being made in State control of air pollution in terms of numbers of programs and the actions of some of them. Greater effort is needed, however, to catch up with the accelerating problems. There are two points which I would stress. One is the need for States, through regulations, to define the standards which must be met. It is unjust to industry to expect it to control pollution if it is not told how much control is needed. It is unrealistic to expect industry to expend funds voluntarily for control equipment when it has no assurance that the results obtained will be acceptable, and when there is no mechanism that requires competitors to make similar expenditures.

The other is that these regulations must be enforced. The task of enforcement is distasteful and often foreign to the orientation of the State agencies who find themselves with the responsibilities for air pollution control programs. It is essential, however, that they recognize and accept the fact that air pollution will not be eliminated solely through exhortation. Until positive and affirmative actions to meet standards are pursued, the only accurate way to describe where a State stands in air pollution control is to say it stands still.

THE CASE FOR A STATE AIR POLLUTION CONTROL PROGRAM

RICHARD J. HUGHES
Governor of New Jersey

One might wonder why New Jersey was chosen to speak for the States at this conference. We are hardly "typical" for we have a geographic location between the metropolitan areas of New York and Philadelphia which raises some unique regional problems.

Yet a close analysis reveals that New Jersey does typify today's urban industrial America with all of its economic and community benefits and some of the resulting negative byproducts of progress. Side by side stand the facts of almost unlimited progress and the ingredients for a broad range of pollution problems.

On 7,500 square miles of area, New Jersey counts 15,000 industries, more than 3 million registered autos, trucks and buses—almost one vehicle for every two persons—and 7 million inhabitants concentrated at more than 900 to the square mile, making New Jersey the most densely populated State. Eighty-seven percent of our population resides in urban areas, compared with 70 percent nationwide. We have more miles of rail trackage than any other State. New Jersey industry annually produces 10 percent of all the chemicals in the United States. In 1965 we stood seventh in the Nation in average annual per capita income. And our industry from 1954 to 1964 showed an increase in value added by manufactures of more than 57 percent.

In addition to its large numbers of plants and motor vehicles, New Jersey is a vast area of fuel consumption of all types. Gasoline consumption rose almost a quarter of a million gallons from 1960 to 1964 alone. In 1965, about 9 million tons of coal were consumed, most of it for power generation by utilities. In 1964, more than 100 million barrels of fuel oil of all types were consumed in our State.

In brief, here is the laboratory State of which former Governor Woodrow Wilson spoke—the modern industrial laboratory of people and things in which progress and air pollution grow apace, and in which we seek methods of air pollution control, abatement, and—ideally—prevention.

New Jersey began its statewide pollution control efforts 12 years ago. Today, that seems like a late start. Yet we were the first State in the Nation to undertake regulatory control of air pollution on a statewide basis, adopt a basic air pollution control law, and establish an Air Pollution Control Commission with enforcement powers.

We started in 1954 with a staff of three and a budget of $24,000. Today our budget is $681,000, with an allotted staff of 60—making ours the second largest State air pollution control program in the United States.

From the basic law we developed administrative codes prohibiting certain specific kinds of pollution and establishing standards of emission. In the past decade, enforcement has been stepped up, accompanied by an increased public educational campaign. Our call for industrial-government cooperation has been coupled with increased regional and Federal-State efforts. Research on new control technology has moved forward. New incentives for prevention of industrial air pollution, as well as control, have been legislated. And, while our technical tools of control are being improved, the public has been given a clearer picture of the deleterious effects of air pollution on health, personal comfort, and our living environment.

What does the experience of urban New Jersey offer other States in mounting a workable and effective Statewide air pollution program?

1. The first consideration is obvious—all State governments should establish Statewide air pollution control programs. The types of programs indicate that only 19 States have such programs, with others moving toward adoption. Although air pollution problems are not yet acute in some less populated and less industrialized States, the time is only 55 years off when America may have a projected population of 400 million, living in a small number of metropolitan areas. At that point, the pollution symptoms so typical of today's metropolitan areas may well appear in all major cities throughout the country.

2. Enforcement procedures must, of course, be one of the keys to pollution control and abatement. New Jersey developed its enforcement procedures along with a series of administrative codes ranging from the complete prohibition of obvious pollution sources such as open burning of refuse, to more difficult problems of establishing standards for emissions of certain gases. Although there has been an active enforcement program, greater public sensitivity and new support from Federal sources have stiffened our attitude toward penalties. We are presently studying the possibility of substantially increasing monetary fines for violations—with the understanding that a monetary penalty is not an end-in-itself, but a symbol of government's determination to treat air pollution as a serious threat to public health and welfare. As a recent Federal report on environmental pollution put it, society must establish the *right to clean air* as a right coequal with the right to economic opportunity and the right to education. Our air environment is public property and requires public protection.

We recognize the various problems involved, for example, in industrial air pollution control. We also recognize that it is sometimes costly and time-consuming to comply with State codes and regulations. Yet, the facts are abundantly clear—code enforcement is one way in which we are going to achieve some semblance of air pollution control. Half-hearted regulations or less than full enforcement will yield weak results. And if present laws and codes are not sufficient, then it is the duty of government to strengthen them or seek new ones.

Laws must be enforced, yet, hopefully, they will not become a factor in interstate competition, so that one industry might be tempted to locate or relocate in another State where air pollution regulations are not too stringent. It is my hope that all the States will one day have equally strong control measures, so that air pollution control, in the legal and public sense, becomes a nationwide precondition for the location and development of all industry.

3. Yet, no air pollution program is going to succeed if it is based solely on enforcement or control of pollution *after the fact.* Programs should be framed which encourage *prevention* of air pollution as well as abatement and control. This means encouraging thinking about development of new fuels. Since we are interested in results rather than accusations, it also means that public instrumentalities can offer certain inducements to industry to help prevent pollution before it occurs. In New Jersey, we did just that this year.

In 1966 the New Jersey State Legislature adopted a law, with strong executive backing, which grants local property tax exemption to industry for the installation of any State-approved air pollution control equipment—old or new. There was some limited opposition to the law, possibly on the grounds of local tax loss to municipalities.

There were others who probably felt that any industry which pollutes should bear the entire expense of pollution control equipment. Yet, if you want some new directions in air pollution control at the source, if you want a cooperative maximum effort from a group as important as industry, then you ought to be ready to offer certain inducements.

We are hopeful that industry and public utilities in New Jersey, which are major point sources of pollution, will take advantage of this new incentive and initiate massive air pollution control programs.

In addition, without the financial investment of industry in crash research programs, and without government-business cooperation to a very high degree, we are going to find that governmental rules and regulations are not the whole answer. There must be self-regulation. There must be new research by industry on new production methods. Government cannot possibly do all this.

It has been one of the happier aspects of the American free enterprise system in the past 30 years that government and business no longer look upon each other as separated by chasms of ideology, but as partners in a new alliance for prosperity.

Los Angeles is a good example of such a partnership. Industry there joined resources with government to try to work toward a solid basis for abatement of the infamous smog problem.

In my own State, a recent survey by the New Jersey State Chamber of Commerce revealed that upwards of $54 million had been spent by New Jersey industries for air pollution control since our control law was adopted in 1954.

In addition, the President of the Allied Chemical Corporation was recently quoted in the press as offering the talents and experience of his own best qualified environmental health people in the fight against air pollution. He said that industry throughout the Nation was already investing $400 million a year in air pollution control efforts.

These are the kinds of industrial effort and innovation which private and public agencies must foster.

4. Air pollution control must be effected through interstate arrangements because pollution knows no geographic or political boundaries set by either nature or man. In some regions there may still be time. But in New Jersey the time for regional control and cooperation is now.

For example, New Jersey fully cooperated in regional air pollution arrangements with the New York-New Jersey Cooperative Committee on Interstate Air Pollution in establishing a regional air pollution emergency warning system. This system alerts our metropolitan area to potentially dangerous atmospheric conditions which produce a heavy buildup of pollutants. When conditions warrant it, an interstate emergency "watch" is put into operation to alert agencies in the area to such acute conditions.

Depending on the severity of the situation, such acute conditions could result in a series of alerts calling for both voluntary and required reduction of large-scale fuel consumption and cutback in incinerator activity, industrial operations, and use of electricity.

The time may come some day when a regional air basin approach to pollution control might be just as logical and realistic as a regional river basin approach to problems of water pollution control, although the factors involved are quite different. The Delaware River Basin Commission—of which I was chairman last year—is a good example of what interstate cooperation can yield with Federal participation on matters of water management policy. We ought to expect similar positive results from future regional air pollution control bodies.

5. States must constantly search for new technological innovations in air pollution control. Just as we invest resources in agricultural and health research, so we are going to have to invest increasing resources in air pollution research and experiment. I am quite pleased to say that New Jersey is an innovator in this technical area.

We now have in operation at three locations in our State a Continuous Air Monitoring Program which daily gives us a clearer picture of total pollution of an air mass; a breakdown as to the kinds of pollutants in the air, and the percentage of such pollutants. Thus, we have a scientific analysis of just what it is we are trying to control and, therefore, what tools may be needed to effect such control. The New Jersey Continuous Air Monitoring Program is designed to furnish exact data about the nature, magnitude and extent of air contaminants in our air mass. We are already learning more about peak periods of pollution. And when the exact nature of the problem is defined, solutions often become apparent.

6. It is obvious that motor vehicle air contamination must be regulated and controlled even though we may never "cure" it short of replacing present fuels with some new source of energy. No one seems to know exactly how dangerous auto emissions are, but we do know they offend our sense of smell, they do damage crops, and they are probably harmful to human health. For whatever reasons—there are many—auto pollution must be curbed.

It is a just tribute to the State of New Jersey that—along with the pioneering efforts of California—we were the first State in the United States to enact legislation augmenting the motor vehicle provisions of the Federal Clean Air Act. This year our Legislature adopted a pair of companion measures which give the State the power to set standards of emission from gasoline and diesel powered vehicles, with appropriate mandatory inspection procedures.

We are presently moving forward in the process of establishing standards and developing inspection procedures. It will not be easy. Some say it is not necessary. But as we look across the land and the growing motor vehicle population—in New Jersey there are almost 400 registered vehicles per square mile—and we are able to estimate the varying quantities of carbon monoxide, hydrocarbons, and other compounds being absorbed by our air, water, plant life, and our bodies—prudence would dictate that auto pollution control is vital and necessary. We are proceeding along those lines, and I think our children will thank us for it.

7. Finally, to receive support and encouragement from the public an air pollution program must be understood by the public—in both its importance and its complexity. Air pollution is complex. It can exist as a threat to public health or simply as a minor source of discomfort. It can and does affect crops, trees, flowers and buildings visibly. It can also affect the permanent condition of the atmosphere which surrounds the earth. Some scientists argue, for example, that the uncontrolled discharge of carbon dioxide could have very dangerous results.

One thing is certain, however, air pollution control is a political issue in the broadest and best sense. Public opinion is aroused about it. Government is actively doing something about it.

New Jersey law defines air pollution in very broad terms as: "the presence in the outdoor atmosphere of substances in quantities which are injurious to human, plant life or animal life or to property or which unreasonably interfere with the comfortable enjoyment of life and property. . . ."

Such a definition lays down a vital challenge not just to New Jersey but to everyone interested in preserving the purity and usefulness of the air around us. We will need improved enforcement programs and extensive public educational campaigns. We will need the fullest understanding and cooperation of the States, local and Federal government, and private enterprise. We will need everyone in our war for nature's preservation. Air pollution is not made in heaven, and I do not believe that a problem made by men cannot be overcome by men. In America, everything is possible.

". . . director of chemical research, Illinois Institute of Technology . . . author of "The Pollution Paradox" . . . research interests in ion exchange, corrosion inhibition, air and water pollution . . ."

THE CASE FOR AN INTERSTATE AIR POLLUTION CONTROL PROGRAM

J. I. BREGMAN, Ph. D.
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Chicago, Illinois

The case for having an interstate air pollution control program rests on two basic premises. The first is the fact that air pollution recognizes no manmade boundaries, but rather is regional in nature, limited only by meteorological and geographical conditions, and must therefore be attacked on the same basis. The second factor is that there are several different governmental levels at which various aspects of air pollution control may be conducted most effectively. The interstate level is one of these.

Although there had been a number of "gentlemen's agreement" types of interstate air pollution control programs adopted in the past, it was not until the Clean Air Act of 1963 was passed that the opportunity to set up such compacts with enforcement powers came into being. Previously enacted compacts were strictly dependent upon good will and attitude and proved to be relatively ineffective. The obviously lacking essential ingredient was enforcement authority.

The passage of the Clean Air Act did two basic things as far as interstate air pollution is concerned. First, it provided the mechanism for a bi- or multi-State group that would have legal and court-enforceable control over air pollution originating in any one State that affected the air in its neighbor. Second, it provided for the possibility of matching funds on a three to one basis by the Federal Government against any new money that was put up by the States involved. Thus, at one stroke, both the authority and the money required to carry out interstate control programs came into being. The final requirement was that such compacts, after being agreed to by the States involved, must also be approved by the Congress of the United States. This last requirement, while reasonable on the surface, has proved to be the big stumbling block to the actual creation of interstate control, and is the reason that the first such compact, that between Illinois and Indiana, has yet to come into being, almost two years after both State legislatures adopted it.

As soon as this authority to develop interstate compacts came into being, Governor Kerner instructed our newly created Illinois Air Pollution Control Board to draw up such agreements with our neighboring States. We approached Indiana first, both because of the severity of the pollution problem affecting both States, and because it was the only one of our neighbors that had a State control board with authority to enter into such compacts. A very receptive attitude was shown by our Indiana counterparts and negotiations began between our two staffs in January of 1964, culminating in a joint meeting of the two boards on February 27, 1964.

The Illinois-Indiana conferees used the Ohio River Valley Sanitation Compact as a guide in laying out some of the principles of this pact. Both States are members of that compact and are pleased with the way it works. In addition, a considerable amount of assistance was rendered the conferees by the Council of State Governments. This latter group did most of the actual drafting of the compact after receiving policy guidelines from the two States.

The final draft of the compact was approved by both control boards late in 1964, and was ratified by the State Legislatures of Indiana and Illinois in June of 1965. It was then introduced into the Congress for approval, and has languished there ever since. Meanwhile, the interstate pollution goes on unabated, even though both States have expressed their intention to do something about it if they are only allowed to do so. Undaunted by this, and hopeful that the concept of interstate compacts will be allowed an opportunity to be tested, we have initiated discussions with the State of Missouri to develop a similar compact, which will cover the problem existing in the St. Louis-East St. Louis area.

It is of interest to examine some of the issues that must be determined in the creation of an interstate compact. These are points which determine the effectiveness of the compact.

The most important aspect of such a compact is a clear definition of the powers of the interstate control group that it creates. There must be no question about the group's ability to take action to stop interstate pollution. Enforcement powers must be given to it, and the conditions under which that enforcement power can be used must be clearly spelled out. In the case of the Indiana-Illinois compact, the recommendations for corrective action are first made to the appropriate local and State bodies by the interstate board. When the interstate board is satisfied that these bodies have not taken remedial action in a reasonable period of time, then it proceeds to do so itself. The principle involved is that the local enforcement agency is first given the opportunity to take the control action. Failure to do so brings action by the interstate body.

The initiation of the determination of the existence of an interstate problem is clearly within the jurisdiction of the interstate board. It has the responsibility for studying the problem, making recommendations for the appropriate corrective action, and then seeing that this action is taken.

It has been suggested by some that the interstate board should replace any other control agencies in its jurisdiction and act directly without first attempting to get local action. This approach has the merit of a swift solution to a pollution problem. It has the disadvantage of requiring abandonment of authority by local and State officials—an abandonment which is certain to be strongly resisted as these local and State agencies are reluctant to give up their responsibilities without an opportunity first to show that they can do the job. The realities of life are such that frequently the local bodies are able to move effectively when they can cite the threat of action by a higher and presumably less understanding board if they do not do the job themselves.

The area of control must be defined. Our experience has indicated that the entire State line rather than only a portion of it should be considered. While interstate problems may be localized at the time of the development of the compact, it makes sense to cover the complete area in which they may develop.

The membership of the Commission and the makeup of its staff are critical. While all sorts of rules and guidelines can be set up, the effectiveness of this body will be dependent on the attitudes of the members appointed to it. The representatives from each State must come onto the Commission with the philosophy that they are concerned with the elimination of interstate problems, regardless of the State within which they originate. The development of a defensive attitude by members for their own State will doom such a body from its very beginning. A constructive spirit, regardless of where the chips may fall, is essential, and people appointed to the body by each State must have this attitude impressed on them from the very start. Otherwise, the interstate body will be ineffective and will have to be supplemented by Federal action.

The appointment of a representative from the Federal Government to the interstate body, and his voting rights, are quite debatable. There are many good arguments to be made on each side. In the case of the Indiana-Illinois compact, it was decided not to have one, while compacts by other States may well vary from this.

The question of the adoption of standards by the interstate body is a key one. There obviously must be a set of reasonably effective standards adopted by this group. Their relationship to the standards existing in the member States must be given considerable attention. This issue is particularly critical, since the effectiveness of the interstate body and its effect on the border problems will be directly related to the standards it adopts.

Provision must be made for funding that will allow the hiring of an adequate staff. Money must be appropriated by both States, and then funds can be obtained from the Federal Government under the Clean Air Act. The staff employed should be given full authority to carry out its duties. It must have competent members, for the tact and diplomacy that will be required in frequent dealings with municipal and State bodies will go a long way to determine the success or failure of the operation.

Finally, the attitude of the States entering into the compact is critical. There must be a desire on the part of both of them to prevent interstate pollution. There should not be finger pointing or inflammatory statements by one group to imply that the compact is the way to correct the evils that are "solely caused by one of the States to the other." As in the case of any agreement between two parties, it will be successful only if both States enter into it in a constructive spirit, rather than in one of mutual accusations.

The need for interstate air pollution control is apparent to anyone who lives in a metropolitan area that is near a State border. The problem is most dramatically a function of metropolitan areas. However, it is noteworthy that many States have more than just one interstate problem.

The large number of interstate air pollution problems makes it clear that there must be a special effort made to deal with those problems. The Clean Air Act gives the affected States an opportunity to handle them by themselves. It still allows for Federal action in those cases where the States fail to do anything. The fact that as of this date there has been relatively little action toward developing interstate compacts is not too difficult to understand since most of the States that will be involved in such compacts are still in the process of setting up their own adequate local and statewide controls. Once these are underway, then one may expect to see an increase in the number of proposed interstate compacts. Meanwhile it becomes important that the pilot case—the Indiana-Illinois compact—be approved by Congress and that the two States involved then take effective action to set an example that will show that interstate cooperation *can* solve air pollution problems.

". . . public health physician . . . state's highest health officer for more than a decade . . . former officer in U.S. Public Health Service. . ."

DEVELOPING AND ESTABLISHING NEW STATE AIR POLLUTION CONTROL PROGRAMS

RUSSELL E. TEAGUE, M.D.*
State Commissioner of Health
Frankfort, Kentucky

It is indeed a privilege to serve on this panel and to be invited to present my views with respect to the development and establishment of new air pollution control programs at the State level.

You are aware, I am sure, of the many arguments pro and con with respect to the State level program. Strong arguments can be made for local control. Strong arguments in favor of State control are the State agency's relative freedom from local influences and pressure groups, and the State's ability with greater financial resources to acquire competent personnel, to purchase more effective equipment, to encourage a greater research effort, and to totally administer a more complete, comprehensive, and sophisticated program. The State can well develop a statewide plan designed to control pollution and to insure uniformity.

In recent years there has been a growing public concern over increasing air pollution. The continued urbanization and industrialization and the greater use of vehicles have been accompanied by increasing detrimental effects imposed by air pollution.

Because of their traditional responsibility to protect the public health and welfare, States must accept key responsibilities in air pollution abatement. Air pollution is not only a constant and continuing threat to the public health, but has its deleterious effects on property, plants and wildlife, and livestock in general. It further causes a community deterioration from its unpleasant odors, unsightly surroundings, reduced property values, and adverse effects on visibility.

It is significant to note that the National Governors' Conference adopted a comprehensive statement with respect to the States' responsibility in air pollution control. Part of the statement was as follows:

"While the role of State government in air pollution control is acknowledged in Federal policy and by the leadership of several States, many States lack effective legislation defining the State's responsibility and have not supported adequate administration of enforcement and abatement activities.

"The first goal of all States should be the enactment of an air pollution control statute which sets forth State policy for air pollution control, provides enabling authority for local and regional programs and establishes a State administrative agency and program. The second element of responsibility is for the State to establish an administrative unit with responsibilities for the control and prevention of air pollution and for research, investigation, assistance to local governments, and education."

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*Read by Ralph C. Pickard, Director of Division of Environmental Health, State of Kentucky.

The statement further designated the specific elements of a State air pollution control program to include:

1. Investigation of air pollution problems and surveillance of air quality on a continuing basis.

2. Preparation of an air pollution prevention and abatement plan.

3. Provision of technical assistance to local air pollution control programs and for cooperative efforts among areas having mutual problems.

4. Coordination with Federal programs and cooperation with adjoining States as necessary to meet mutual problems.

5. Conduct or support of research for increasing the effectiveness of air pollution control technology and its application.

6. Conduct of educational programs to encourage public interest and support for air pollution control.

Lastly, three strong recommendations were made by the Governors' Conference, as follows:

1. State governments should accept major responsibilities for air pollution abatement and prevention and enact legislation to enable them to carry out these responsibilities.

2. A State air pollution control statute should include an air pollution control policy statement; an administrative agency and program to implement the policy through investigation, planning, research and education; enabling authority for community and cooperative local programs and for State assistance to such programs; liaison and cooperative relationships with Federal programs; and enabling provisions for interstate cooperation.

3. To meet its share of the challenge, a State must obligate sufficient staff and budget to implement effective air pollution control activities.

If any program of air pollution control is established or developed, considerable knowledge must be gained with respect to the problem throughout the State. The public must be made aware of the problem and must be well informed with respect to the purpose, objectives and activities of the air pollution control program proposed to be developed. It is also essential that the public be made aware of its responsibilities toward support of the program for the alleviation of air pollution.

To the above must be added the cooperation and coordination of all levels of officials and the complete awareness of the public and the interested officials that sufficient funds must be made available to carry out the designated program.

If any such program is to succeed, it must have the full and active support of industry, public officials, the business community and citizens, all working toward the common goal of air pollution control. The public as a whole must be aware and concerned for the need for such air pollution control. It should be further pointed out that if a program is to succeed, legislation for control must be reasonable and must be based on technically substantiated criteria which will provide flexibility, but which at the same time are sufficiently specific to meet the needs of the State.

We must keep in mind that the program may, in its early development, be concerned with abatement, but the emphasis must shift to control through prevention if the program is to succeed.

In spite of these handicaps, the States are slowly staffing for the attack on air pollution. The time schedules envisioned by the granting agency may be too optimistic considering the existing limitations. Here we're speaking of limitations of attraction of the necessary personnel. Some State air pollution control agencies not based in health departments have had an even more difficult personnel situation, since they had no existing personnel with basic knowledge on whom to rely for any aspects of program development.

Inadequate legislation, as everyone knows, is a major roadblock to proceeding beyond the developmental stage. A common experience is to have two or three bills turned down before one is passed that hopefully provides an effective basis for air pollution control. Weaknesses in some State laws continue to render the States unable to deal effectively across the board with health and nuisance problems, and result in a less-than-adequate basis for dealing with multijurisdictional needs such as multicounty or interstate situations. Some of their problems with dissident persons and groups who have influence with legislators have been resolved through the use of discussion committees composed of individuals representing various interests of industry, government, and the general public. This method was effective in Kentucky after failure of one bill in the State legislature. That this procedure was successful was evidenced by the unanimous approval of the final bill in both houses of the State legislature. It must be admitted that the Federal abatement provisions of the Clean Air Act served as a strong catalyst in stimulating these sincere interests in State legislation. In spite of temporary setbacks, many of the States feel optimistic about the prospects of obtaining necessary legislation to permit their further participation in the Federal grants program.

One cannot discuss progress in any field without mentioning money. Some of our States have experienced difficulty in getting started because all their limited budgeted funds were committed. Legislative appropriations have depended upon the presentation of facts supporting the needs for such monies. Thus a cycle evolves which is not uncommon in the development or establishment of new programs. Here again some of us have borrowed money and personnel from existing programs to get a toehold in the new area of operation. Apprehension has been expressed by some States about the assurance of a continuing program based on Federal grants. It has been our experience that no difficulties have arisen so far in the continuity of grants. This is due to the fact that our request for money has been in early enough so that the granting agency had time to take the necessary action to keep the program operative.

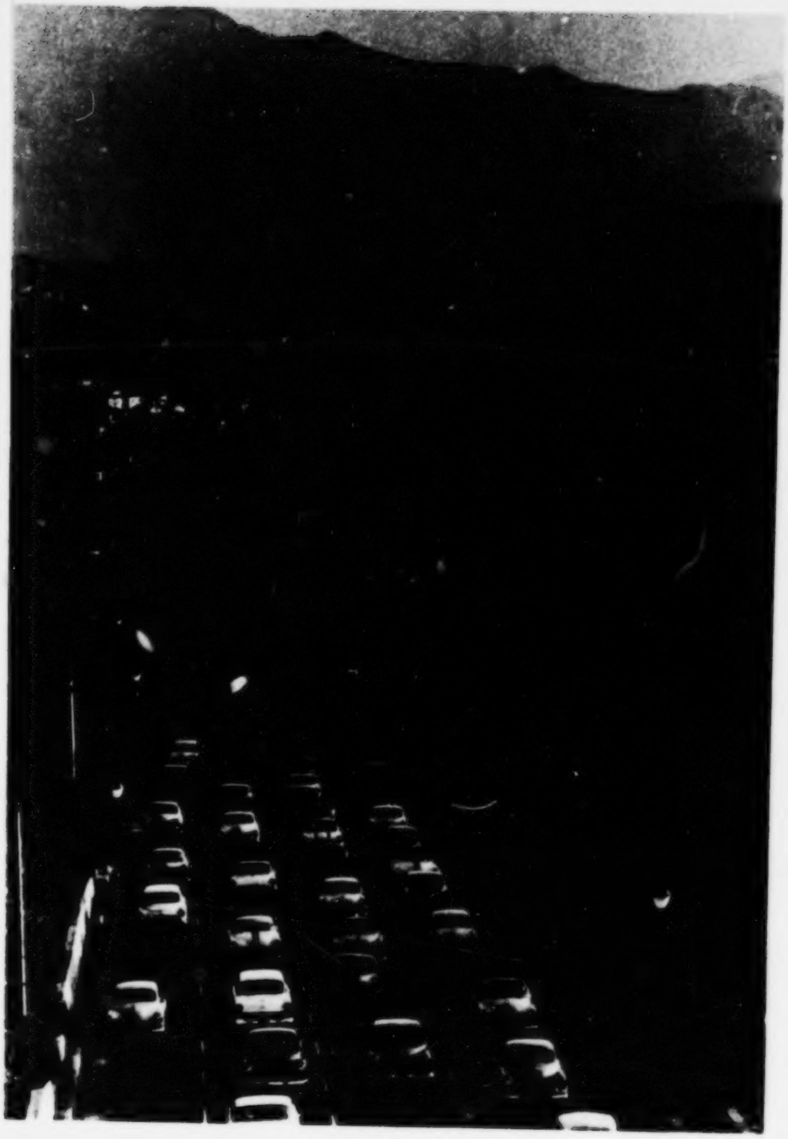
Air quality standards are a matter of concern to States which are pondering the establishment of regulations and standards. This may be an important factor in delaying the pursuit of control programs. After some 15 years or more of water pollution control programs, minimum standards for water quality are now under consideration in the Ohio River Valley watershed, and they will probably provide some uniformity from State to State. In the absence of a similarly developed set of standards for air pollution, some States are concerned lest they place themselves at a disadvantage with respect to attracting new industry. While land use and other factors are variables nationally, there is an urgent need for generally acceptable criteria which may be applied among all the States as guidelines. Such standards appear to be a long way off in the field of air pollution.

If one looks at the recommendations coming out of abatement proceedings of the Federal Government, such as those relative to the abatement of the odor problem in the kraft paper industry, one might conclude that nothing less than the best control possible will be acceptable to the Federal Government in regard to interstate problems. Furthermore, it is questionable whether any air pollution problem is strictly intrastate. Clarification of acceptable limits of air pollution is essential to a practical, preventive approach to air pollution control, short, that, is of absolute control at all levels of government, whether Federal, State or local.

Selling the need for an air pollution control program to the public, to the chief executive of the State, and to the legislators, is the key to achieving legislation and money. Nonpartisan support of an air pollution program may not be easy to come by, but a well planned publicity campaign is helpful. The stepped-up attack on this problem from Federal and other agencies has made a significant impression on the minds of a large segment of the public and it is an advantage which should not be lost.

Timing is also important in promoting a program. The political climate and other pertinent current public issues require consideration. Providence, it seems, must sometimes be on our side, in addition to our own efforts, to achieve our objectives so that a combination of factors are favorable at any given time.

Another important factor in developing and establishing air pollution programs is the use of available resources. Chief among these are the various aids in the air pollution program of the Public Health Service, including the regional representative, and



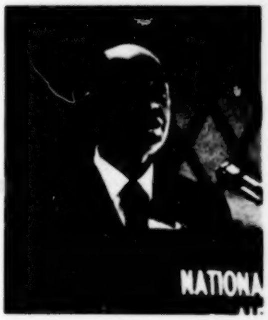
the information, legal, finance and grants sections. Starting with the developmental program and following the natural sequence of an establishment program possibly has some advantages over starting from some intermediate point. The procedure is possibly somewhat simpler and more clearcut. Regardless of the accuracy of this assumption, our experience with the granting has been to date quite satisfactory. Largely because of our close communication with the Public Health Service, we feel that we have made a good start toward Kentucky's assumption of its proper role in control of its air pollution problems.

In conclusion, there are three opinions which I would like to emphasize: First, the Clean Air Act has provided the impetus and the motivation necessary for the implementation of State air pollution control programs throughout the Nation. Second, the States have responded to this stimulus generally with enthusiasm. Third, while progress has been commensurate with the efforts expended, it is obvious that a better effort is needed to overcome some of the obstacles encountered thus far, notably personnel problems and money requirements. This will be necessary for progress to take place at the rate all of us would like to see it.

A complete and permanent solution to program development leading toward the alleviation of air pollution would be desirable, but is a practical impossibility due to changing conditions and technological advances. A conscientious, extensive effort in correlation with well-planned state legislation will do much toward solving this problem.

". . . industrial chemist and public health official . . . directed air pollution study in Kanawha Valley . . ."

IMPROVING EXISTING STATE AIR POLLUTION CONTROL PROGRAMS



CARL G. BEARD, II
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State Air Pollution
Control Commission
Charleston, West Virginia

I will divide my remarks into two phases: first, what I believe has been helpful in improving our program in West Virginia; and second, what I believe would be helpful to any State to improve an existing program. This represents my personal opinion.

When I was asked to give this presentation, I was cautioned not to be concerned with inadequate finances, personnel, or equipment problems, as these are common to all agencies. Unfortunately, these seem to be the major problems. I will only say that we have these problems too.

To make this presentation more meaningful, some background and history of our program is necessary. Our air pollution problems in West Virginia encompass a variety of sources, including multichemical plants; steel, aluminum, and other metallurgical production; power generation; coal preparation; burning coal refuse; and those "other" problems we all have.

We were established as a separate agency of government just over four years ago, but only in the last two years have funds been made available to enable us to take meaningful steps in the measurement and abatement of our air pollution problems. This became possible when we received our first significant State budget and combined it with matching Federal funds. We were one of the first two States to receive a Federal grant under the Clean Air Act.

Two years ago, the Commission also requested the assistance of the PHS National Center for Air Pollution Control in conducting a study of the greater Kanawha Valley. Most of this study has now been completed. It consisted of: an emission inventory study, an ambient air quality measurements study, a meteorological study, an odor survey, a materials deterioration study, a vegetation ecology study, a public attitude study, and a health effects methods study.

Just over a year ago, the Public Health Service also began conducting interstate air pollution investigations in three areas along our border. An abatement conference has recently been called by the Secretary of Health, Education, and Welfare in one of these areas. We are also conducting several studies throughout the State, including these three areas.

We have made some progress in the control of air pollution during the last three years. At the Commission's request, industry has submitted programs to control various types of particulate emissions. These approved programs will require the expenditure of 28 to 30 million dollars in the Kanawha Valley air basin over the next few years for this pollutant alone. Programs to control particulate in other areas of the State will require the expenditure of 10 to 11 million dollars. Part of these expenditures have been made and the equipment is now on stream.

As part of the Kanawha Valley Survey a thorough emission inventory was made of all pollutants. An intensive ambient air sampling program was conducted in the area for some pollutants. You will notice I said *some* pollutants, because measurement of all pollutants in a multichemical-producing area is not yet possible. Based on the emission inventory and the ambient air quality data, an air quality program for particulates was projected. From this information our Regulation II to control combustion particulate in the Kanawha Valley was promulgated. This regulation sets emission limitations on fly ash and smoke. As far as I know, it is the most restrictive yet in existence but it is what has been deemed necessary in order to develop clean air for this area. Because it was so restrictive, representatives from outside of the State were present when the Commission held the public hearing. None of these out-of-State representatives, except one member of the Public Health Service, was there to support the proposed regulation. It was also discussed publicly at places far removed from West Virginia. The criers of doom and gloom were sure we were going to force everyone into bankruptcy. If the regulation had not been based on data and had not had strong public support, it would have been very difficult, if not impossible, to promulgate.

Public demand and public support for clean air are two of the most important features of any program. It is very difficult to go it alone, since the polluters will certainly call it to your attention if this support is lacking. We have been fortunate in having excellent support in our efforts so far. If demand and support are openly voiced by the news media, so much the better.

You will note that I did not say public understanding—understanding of the agency problems. This is a problem we haven't solved as yet. The demands for clean air are now coming faster than we can service them. Hopefully, at some time in the future we can achieve a better balance in this realm.

As I mentioned earlier, another extremely important asset of any abatement program is reliable and sufficient data. Although there may be differences in the individual interpretation of data, the mere possession of reliable data is in itself an effective "lever" in removing stumbling blocks. With data you are dealing from a position of strength; it is then not a matter of what you think or I think or they think of the quality of the air, but what you know that quality to be.

Thus, when the polluter is confronted with a public demand for clean air, and data from the control agency supporting that demand, and when he knows you speak with some knowledge of his operation, the stage is set for abatement.

In staffing, some prior industrial experience can be an asset. Industrial experience that has given knowledge of how a corporation functions on the working level is helpful. An understanding of any phase of an industrial operation can be a large asset. Of course, a prime requisite is a belief in the need for clean air.

The economics of controlling air pollution is highly complex. The matter was discussed at the National Conferences of 1958 and 1962 and is still with us today. I don't believe we have gained very much in that time. The cost of a control device is difficult to obtain, but some reasonable estimate can usually be made. The cost of installing this equipment is even more difficult to obtain since it varies from plant to plant and area to area. The first cry of the polluter is that it costs too much. He would like to settle for less restrictive and also less costly control devices. He will tell you that the cost of the control device, when added to his other costs of production, will make his products noncompetitive, both with those of other companies and of other plants within his own corporation. Basic raw materials and power costs, nearness to market of the product, labor costs, means of transportation, age of the plant, costs of financing, and other factors, make an interrelated financial jungle. All of these may be named by the polluter to support his case. He will also remind you that money being spent for control devices would earn a better rate of return if invested in production equipment.

In order for any control agency to make any reasonable estimate of true costs, it would have to have a highly competent staff of cost accountants and expert legal advice on corporate structure as well as having access to the polluters' books.

In West Virginia most of our air pollution problems have been with us for quite some time. If some means can be found to provide financial incentives to at least control our present problems, it would be helpful. Congress has taken a step in the right direction in retaining the 7 percent investment credit for these devices. More substantial incentives must be found.

At the State level, we need assistance in developing ambient air criteria. The Public Health Service has been slow in developing these criteria at the national level, and a review of the standards or criteria of other States or areas shows some considerable variations. The 1963 Staff Report to the Committee on Public Works, U.S. Senate, stated that 35 States and Guam, Puerto Rico, and the Virgin Islands needed assistance in this area.

The following is quoted from that report: "Most States seem to be wary of direct Federal action in air pollution control, but admit their own inadequacy in the fields of research, including the development of criteria for standards of air quality, and seem to favor expanded Federal action in these areas."

At the State and local level, the Public Health Service has been active and helpful in suggesting ambient air criteria. But as yet, no criteria have been established on the national level. It is completely unreasonable for the States to make these decisions on criteria when they do not have the extensive literature resources and large medical staffs, nor the time to interpret this information as it relates to the effects on health. Public pronouncements have been made concerning the danger of pollution to health, but nothing specific is given as to what criteria are acceptable for any pollutant.

"Pollution" varies from area to area and there is a wide variation in pollution emissions in different areas of West Virginia. Does this "pollution" have the same health effects in all areas or is it really pollutants that we should be concerned with? Granted, today only tentative values can be set for many of these pollutants.

When the criteria are presented, it may seem impossible to meet them when economics and present control technology are considered. But they will be there as goals to work for tomorrow. How long it will take to reach these goals, we won't know until the criteria are established and we have knowledge of air quality in any given area.

Only when these criteria are established, can any State or local area properly evaluate the total problem. The States are being pushed to set their own criteria without adequate information by the demands of the public for clean air. If through lack of information the State authorities set their criteria too high, they would be open to criticism by all.

We also need more specific information on the economic effects of air pollution.

Information is needed as to the reliability of various types of sampling and monitoring equipment, since many new agencies are now or soon will be purchasing this equipment. The instruments are in many cases complex, and comparative information concerning their selectivity and reliability are almost nonexistent. It would be highly desirable for the Public Health Service to establish an air pollution equipment testing program with frequent reports to State and local agencies as to equipment performance. This is very important since these instruments are essential to any air pollution control program and an integral part in the establishment of ambient air criteria. The agency should monitor with the same methods as used in establishing the criteria or know the deviation in the two methods.

In summary, I believe the best job an agency can do is marshall the facts, develop public support, and do an effective selling job for clean air. The demands are for clean air *now;* at least they are in West Virginia.

REFERENCES

1. Staff Report, Committee on Public Works, U.S. Senate, 1963.
2. West Virginia Administrative Regulations, Air Pollution Control Commission, Series II, 1966.

QUESTIONS AND COMMENTS

PETER J. BRENNAN (*Associate Editor, Chemical Engineering Magazine, New York City*): Would you say, Mr. Yaffe, that some State programs or laws have been enacted for the express purpose of thwarting effective control, to preempt the field, so to speak, from perhaps more vigorous enforcement at the local level? The charge has been made that this is precisely what was done in Texas, for example, where the law certainly reads that way.

YAFFE: I'm a native of Texas, I'm not going to answer that last part. I think these laws speak for themselves. I think all you have to do is read them and you can get the answer.

DAVID G. WARREN (*Professor of Public Law, University of North Carolina*): In regard to interstate compacts for air pollution control, the only question for Congress to decide in reviewing the Illinois-Indiana compact is whether the arrangement interferes either immediately or potentially with the Federal-State balance; i.e., whether it infringes on Federal authority and responsibility. The answer to successful interstate air pollution compacts may lie in including the Federal Government as a partner, as an active member of the regional commission. A good example of this is the Delaware River Commission. But if a compact with enforcement powers is not achievable, either because of lack of State legislative action or lack of Congressional approval, concurrent regulation is an obvious solution.

BREGMAN: Professor Warren's points are very well taken. I agree that, if we don't get a compact, then the solution is to work together with concurrent regulations. Of course, this is not nearly so effective as a single group that controls both sections, but it certainly is the thing to do if you can't get the compact.

J. BROOKE DUVALL, JR. (*Vice President, Baltimore Transit Co.*): What standards are set for motor vehicles? Is there any distinction between gasoline and diesel? What corrective devices, if any, are required for motor vehicles; have they proved to be efficient?

ROSCOE P. KANDLE (*New Jersey State Health Department, Trenton*): I can't answer very much of that. We do not now have standards. They will be developed within a year or so, I hope. But the New Jersey concept is one of following up on the Federal standards. That is, we assume that the new cars will either have motors that operate with less air pollution or will have control devices. The New Jersey approach is to keep those automobiles, as well as all automobiles, working at their maximum efficiency and with minimum air pollution. How we're going to measure this and exactly what emission standards will be set we don't know, but they will be performance standards. Our law does differentiate between gasoline- and diesel-powered vehicles, and there will be two separate programs dealing separately with them. We don't know whether this is going to work or not; we haven't tried it. We do have a statewide motor vehicle inspection system and air pollution control is to be built into the normal annual or semiannual inspection program, but we don't know how to do that yet.

JOSEPH J. WEINSTEIN (*Director of Environmental Health, Maricopa County Health Department, Phoenix, Arizona*): There are many variations in State air pollution control laws which pertain to the basis for granting variances from an order of the control officer. What criteria would be suggested or recommended as being the most responsive to the needs of a State or region?

BEARD: In our statute in West Virginia, nothing is spelled out as far as variances are concerned. The Commission has the power to promulgate regulations. A variance section is included in the regulations. The regulations can be modified from time to time. This leaves you some leeway, rather than having every detail included in the statute.

EMIL T. CHANLET (*Professor of Sanitary Engeering, University of North Carolina*): Mississippi and Delaware have created air-water pollution control agencies or commissions. There are rumors of some States pushing for the same in air pollution. Are there bona fide analogies between air and water pollution control? These bode ill for the public health management of air pollution.

YAFFE: I have to base my answer to this question on what I see when I look around at what is happening. As I mentioned in my paper, some of the programs are located in health departments, some are set up in agencies which jointly administer water and air pollution control, and some are separate air pollution control agencies. Regardless of what I personally think is the best way, from observation I have seen poor results and good results with each method. If I seem to be evading your questions, it is not on purpose.

KANDLE: I think a much more logical approach would be to marry air pollution and solid waste disposal. God knows we've got enough to do there.

JAMES L. DALLAS (*Sanitary Engineer, Massachusetts Department of Public Health, Boston*): If two States such as Illinois and Indiana have a strong desire to clean up their interstate air, why don't they shake hands across the border and clean it up? Lack of a compact should not be a deterrent.

BREGMAN: There can be no argument with what you said. In practice, though, you don't get air clean-up unless there is one body that specifically worries about the problem and has the authority to do something about it. The fact that the two States have agreed that there is a problem that needs solution is a step forward. The fact that they're willing to create a board that can do something about it is a major step forward. Each State has problems throughout its own State and concentrates on those problems. The border area is just one of the many problems within the State and that probably is the major reason why it's desirable to have a separate group that worries only about the border area.

KANDLE: I want to make it clear at the outset that I am not against regional or interstate agencies or compacts, but I do disagree with many of the premises that Dr. Bregman set out. I don't believe that it's necessary to have an interstate agency. When there is some particular problem, for example, if a whole area in New York were to decide to use a different kind of fuel, that would be a much better approach than going after it city by city. But when it comes to point-source control, I don't see any need for interstate action.

BREGMAN: Let's take a specific case where you have States with several communities near the border, perhaps small communities, where you're getting a lot of pollution. For several reasons, I don't think you're going to get much action by the small individual communities. They don't have the staff, they don't have the money, and the industries that are doing the polluting are the basis for their economic livelihood. You're not going to get the State really going after them for the reasons I mentioned earlier. On the other hand, you need somebody to worry about your problem and to be in a position to do something about it. Obviously, the interstate group doesn't replace the need for local action, but I think you won't get sufficient control at the local level in many of these cases.

KANDLE: I want to make it clear that in New Jersey we have such a body that is worrying about interstate pollution and we have the authority. If we fail to use it, I am the one who is to blame.

HARRY M. BOWMAN (*State Chairman, New Jersey Council for Research and Development, Newark*): Since all the speakers this morning have been from government agencies, I as a member of industry would like to say that we in industry also feel that there is a vital need for stopping the finger-pointing and name-calling and get on with the job, as Vice President Humphrey said yesterday.

WEINSTEIN: We have heard clear evidence of international air pollution problems. Was this lend-lease pollution? Would any panelist care to discuss the implications of this for now and the future?

BREGMAN: I would like to comment on this briefly, but use another example, not the United States and Canada, but rather western Europe. A few years ago I was privileged to be scientific advisor to the Science Committee at the NATO Parliamentarians Conference. They were discussing common environmental problems in Europe, one of which was air pollution and its spread across national borders. They talked about the fact that there is such a problem, they agreed that they ought to do something about it, they agreed that they ought to cooperate on it, and then everybody went home, and that was the end of the cooperation.

KENNETH N. HENDERSON (*Representative, Region 3, United Automobile Workers, Indianapolis*): Recognizing the urgency of our national air pollution problem, I respectfully urge a series of regional conferences to recommend and discuss minimum standards for all the local officials, industry representatives, and citizens to support in order to mobilize a united and immediate effort in this critical situation.

MRS. ROBERT I. BALLOU (*President, New Jersey Citizens for Clean Air, East Orange*): Many interested citizens have come to this conference from all over the country. One of the prime objectives is stimulation of public support for immediate solution of the nationwide problem.

Earlier today, Governor Hughes expressed the case for a State air pollution control program. New Jersey Citizens for Clean Air supports a State program, but wants it amplified. What is needed is a realistic budget which will attract planning and enforcement officers of courage and dedication. Government officials want and need the support of citizens on local, State, and national levels for the achievement of an effective control program.

Specifically, New Jersey Citizens for Clean Air is coordinating existing citizen groups, and encouraging the development of new organizations which will have as a major objective the education of the public regarding the needs for and the costs of controlling existing air pollution sources and preventing new sources. To this end we favor increased opportunities for participation by the general public in the commissions and other bodies involved in the total program.

ALAN D. GOODWIN (*Member, Pennsylvania State Planning Board, Harrisburg*): I am a land-use planner, not an air pollution scientist. Throughout the conference, I have attempted to relate land-use planning to pollution in the air. I think we land-use planners need a great deal of help from you specialists in determining poor locations for future cities, locations where excessive pollution will take place. I don't know whether or not Los Angeles would have been established where it is today if there had been air pollution scientists when it was founded. I'm sure there are other economic factors involved. I am concerned with land-use performance standards and zoning in Pennsylvania. For example, there are six counties that have county zoning. I'm sure that in most cases they rely on the old zoning categories of heavy industry and light industry instead of performance standards. This is certainly a grassroots problem that must be solved.

BREGMAN: We are looking at this pretty intensively in the metropolitan Chicago area. Our metropolitan planning commission is laying out examples of control opportunities. In air pollution, in water pollution, in floods, in a whole host of environmental disasters, we find that many can be prevented from ever occurring in the first place if the land-use planning is proper. The pattern is set for these disasters when the communities are developed, generally in unincorporated areas with little or no planning, little or no zoning control. The situation is set up, the developer goes away, and then all of a sudden we realize that we have a problem. I think we tend to overlook land-use planning because we are so concerned with the problems that exist today and how we're going to correct them that we don't worry about the prevention of future problems. I think land-use planning is a very important tool that we must make full use of.

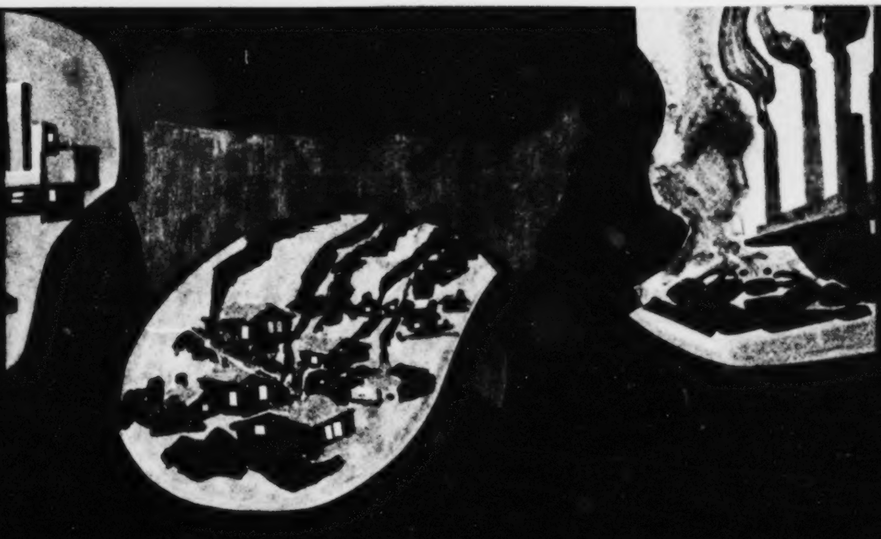
LEVEE: The County of Los Angeles, which is the major part of the basin of Los Angeles, has a very rigid system of zoning and no plant is allowed to be built in Los Angeles unless it's 100 percent controlled now and in the future.

ELEANOR SLATER (*State Senator, Warwick, Rhode Island*): Why not include legislators in conferences on air pollution? They implement laws and they have a primary role in enacting State and interstate laws. I noticed a dearth of legislators from other parts of the country here and, in going from one panel session to another, which I have done all morning, I noticed a wealth of material, the very kind of thing that legislators need to fight for air pollution legislation. I would not have been here today if industry hadn't built a fire under me to attend, because I have been very vocal in my own State about air pollution. I feel very strongly that, when future conferences are planned, efforts should be made to get state legislators to attend, because these are the people who need this kind of argument and this kind of data and this kind of information in depth, so that when they get up on the floor of their own legislatures and argue for the passage of air pollution legislation, they will have some background knowledge. It is this kind of conference which we who are nonprofessionals in the field need most. After all, we can have a group of professionals in our State asking for our help, but we are the people who have got to do the talking and the shouting with whatever information is fed to us.

I have gotten a tremendous amount of good out of this conference and I'm only sorry that more other legislators from my own State and other parts of the country haven't been here, too.

FRECHETTE: Amen to that. If there are regional conferences, I think they would provide an excellent opportunity to involve local legislators.

YAFFE: I wasn't a member of the steering committee. so I don't know what went on in their meeting. But I'm certain it was their intention to try by every means possible to attract the very people you're talking about to this conference.



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December 13, 1966

PANEL F

LOCAL OR REGIONAL AIR POLLUTION CONTROL PROGRAMS

Chairman Robert A. Low
Councilman, City Council
New York, New York

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" . . . attorney . . . former legislative assistant, U.S. Senate . . . State Department liaison . . . founder and first president of N.Y. Citizens for Clean Air . . ."

STATUS REPORT

ROBERT A. LOW
Member, New York City Council
New York City

It is very difficult to separate the subject matter of Panel F from that of Panel E. For that reason we are scheduled to have a joint session this afternoon. The Panel E session is devoted to interstate matters, whereas this panel is devoted to local or regional air pollution. If you come from the City of New York, you are, by virtue of the situation of the City, dealing with interstate problems. My remarks, therefore cut across the subject matter of the two panels. They deal primarily with the problem of regional control and what can be done through the Clean Air Act.

I am pleased to note that there is a growing awareness of the need for prompt action on a regional basis, as well as on a national basis, to deal with the variety of mutual problems which we have. Unfortunately, the Interstate Sanitation Commission in the New York Metropolitan Area, primarily concerned with the problems of New Jersey and New York, not only in air pollution but also in water pollution, is virtually powerless to do anything about air pollution. It is ineffective, understaffed and fundless, in part because the two States involved have not provided adequate financial resources. It has only a handful of employees and a $40,000 budget. It has no powers of regulation. It got off to a poor start and enjoys so little public confidence, that the only sensible thing to do, in my judgment, is to start all over again. That's what I propose we do.

Regional action is clearly indicated and necessary in this area. Aside from the logic of such action, there is ample precedent. We have an interstate Port Authority and a tri-state Transportation Commission and, despite the deep-rooted veneration for local government and States' rights, the spectacular growth of Federal aid over the years has coincided with an erosion of local and State power, particularly in this area. Grants to State and local units have grown from $7 million in 1902 to some $15 billion at the present time.

Fortunately, the Federal Government has made regional planning a condition to the receipt of aid under some programs, as under the Mass Transit Act and the Federal Highway Act. When we anticipate the receipt of Federal aid for the construction of a highway or new subway cars or any other mass transit facility, we cannot expect to receive that aid unless the facility is part of a plan prepared by the interstate Transportation Commission.

Unfortunately, the grant-in-aid approach under the Clean Air Act has not worked in the field of air pollution control, precisely because there is no requirement that local efforts adhere to area-wide standards or regulations. As a result, Federal funds continue to pour into inadequate localized programs which have little or no relationship to any uniform area-wide approach to the problem.

It should be clear by now that in the New York metropolitan area, the industrial smoke pumped into the air over Newark, New Jersey on Monday may well be the soot on the family laundry line in Bridgeport, Connecticut on Wednesday, after irritating eyes and nasal passages in Manhattan, the Bronx and Westchester on Tuesday.

The Clean Air Act also misses the mark because it does nothing to encourage cooperation between the States, while it promotes conflict through the provision for institution of abatement proceedings between States, wherein one State complains of pollution from another. An abatement proceeding was thus initiated upon the complaint of Governor Rockefeller of New York; it was answered by the institution of similar abatement proceedings by Governor Hughes of New Jersey against New York. In effect, we had an adversary proceeding. It seems to me that we need cooperation rather than conflict.

I suggest that there should be established immediately in areas like ours a "metropolitan air pollution control district," such as exists within some States. This unit should have power to establish standards and regulations, but should leave enforcement to local units, perhaps countywide in jurisdiction. So that people cannot complain about "super-government," I feel it is preferable to secure enforcement through local governmental bodies large enough to be effective, but not so large as to create the horror of "super-government."

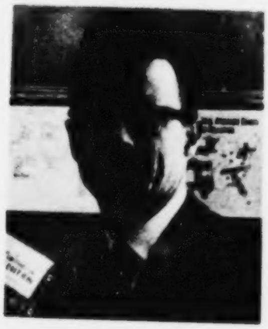
In the New York metropolitan area, we have some 1400 different local political subdivisions—air pollution control areas, school boards, villages, towns, counties, cities, etc. We have to cut through this morass of political subdivision; the Federal Government can be the key to such a step if the Clean Air Act is amended to provide for withholding moneys under the grant-in-aid formula from any air pollution control agency that refuses to adhere to regional standards and regulations.

What I have in mind is that the district created by neighboring States would set standards and regulations. The Federal money would be funneled to the district and the district would allocate those funds only to air pollution control agencies that enforced the regional standards and regulations.

I am urging and will continue to urge the legislatures of the three States in our metropolitan area to establish a metropolitan air pollution control district. I hope Congress will assist this by the suggested amendment to the Clean Air Act. A regional approach would cut through this hodgepodge of some 1400 political subdivisions in the tristate area and would be a sensible approach not only to this air pollution problem, but perhaps to other problems of space age America.

". . . public health engineer in air pollution programs since 1955 . . . in charge of PHS air pollution training programs . . . supervises studies of State and local air pollution problems . . ."

A ROLL CALL OF THE COMMUNITIES—WHERE DO WE STAND IN LOCAL OR REGIONAL AIR POLLUTION CONTROL?



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INTRODUCTION

Community air pollution control activities began many years ago in connection with control of odors from offensive trades such as candle factories, rendering plants, and pigsties. Later on, beginning in the late 1800's, smoke abatement activity was added. Since the advent of Los Angeles-type smog in the late 1940's, communities have become concerned with comprehensive air pollution problems. Local governments have, in the past, been the most active in the air pollution field because of the traditional delegation of police, nuisance, and public health powers to local governments. In more recent years, States, and especially the Federal Government have entered the field; but local governments are still by far the most important entities for regulation of air pollution, and they probably always will be. In this report, the status of local governmental air pollution control activities will be described, with only nominal reference to State or Federal activities. For purposes of this report, "local" government means any single agency or group of agencies smaller than a State and excluding all Federal agencies.

EXTENT OF LOCAL GOVERNMENTAL AIR POLLUTION CONTROL PROGRAMS

Existing Air Pollution Control Programs

In November 1965, there were about 130 city, county, and multijurisdictional air pollution control agencies in the United States (Table I). The list includes only those spending at least $5,000 per year. The number of areas served was actually 123 (vice 130) because of dual coverage in seven cases. Los Angeles County, California, with a budget of $3,663,000, was the largest agency. Agencies in California accounted for 38 percent of the total expenditures. The seven largest agencies accounted for 58 percent of the total budgets. Only 42 agencies had a budget of $50,000 or more, which is actually a bare minimum program budget.

These local agencies collectively served 63 million people, only about half of the total urban population. The programs were spending an average of 23 cents per capita served. The median program budget was 15 cents per capita. The total budget of local agencies was about $10.7 million. To this was added $3.6 million in Federal grants,[2]

TABLE I.—*Local air pollution programs and budgets*

[Agencies spending $5,000 per year or more as of November 1965]

City or area	Population 1960 (1,000)	Budget, 1965 ($1,000)			1965 per capita budget (cents)	1961 budget $1,000)[2]
		Non-Federal	Federal[1]	Total		
1. Huntsville, Ala	72	5	E 10	15	20. 8	0
2. Jefferson County (Birmingham) Ala	635	42	D 121	163	25. 7	12
3. Mobile County, Ala	314	7	D 22	29	9. 2	0
4. Maricopa County, Ariz	664	72	E 57	129	19. 5	0
5. Pima County, Ariz	266	8	D 25	33	12. 4	0
6. Humbold County, Calif	105	7	0	7	6. 7	0
7. Los Angeles County, Calif	6, 039	3, 453	I 210	3, 663	60. 8	3, 402
8. Orange County, Calif	704	126	0	126	17. 9	117
9. Riverside County, Calif	306	86	0	86	28. 1	67
10. Sacramento County, Calif	503	28	0	28	5. 6	50
11. San Bernardino County, Calif	504	207	I 77	284	56. 3	259
12. San Diego County, Calif	1, 000	68	0	68	6. 8	79
13. San Francisco Bay Area, Calif	3, 291	990	I 58	1, 048	31. 8	560
14. Ventura County, Calif	199	10	[3] 20	30	15. 1	0
15. Adams and Arapahoe Counties, Colo	234	12	E 36	48	20. 4	0
16. Boulder City-County, Colo	74	2	[3] 7	9	12. 2	0
17. Denver City and County, Colo	494	62	I 89	151	30. 5	15
18. Bridgeport, Conn	157	12	E 22	34	21. 6	0
19. Fairfield, Conn	46	8	D 15	23	50. 0	0
20. Middletown, Conn	33	7	D 12	9	57. 6	0
21. New Britain, Conn	82	7	[3] 14	21	25. 6	0
22. Stratford, Conn	45	7	D 15	22	48. 7	0
23. Washington, D.C	764	45	I 33	78	10. 2	42
24. Metropolitan Washington Council of Governments	1. 736	7	[3] 21	28	1. 6	0
25. Dade County, Fla	935	40	I 64	104	11. 1	5
26. Hillsborough County, Fla	398	10	0	10	2. 5	0
27. Palm Beach County, Fla	228	13	E 39	52	22. 8	0
28. Pinellas County, Fla	375	10	0	10	2. 7	0
29. Polk-Hillsborough Counties, Fla.[4]	593	142	0	142	23. 9	50
30. Atlanta, Ga	487	13	0	13	2. 7	13
31. Fulton County, Ga	556	6	D 18	24	4. 3	0
32. Macon-Bibb County, Ga	141	5	D 16	21	14. 9	0
33. Chicago, Ill	3. 550	770	I 393	1. 163	32. 7	364
34. Cook County, Ill.[5]	180	100	I 50	150	83. 3	0
35. Peoria, Ill	103	6	0	6	5. 8	8
36. Will County, Ill	192	6	[3] 16	22	14. 5	0
37. East Chicago, Ind	58	19	I 15	34	58. 7	11
38. Evansville, Ind	142	14	I 11	25	17. 6	10
39. Gary, Ind	178	43	I 63	106	59. 6	0
40. Indianapolis, Ind	476	40	0	40	8. 4	38
41. Terre Haute, Ind	72	11	0	11	15. 3	0
42. Cedar Rapids, Iowa	92	5	D 11	16	17. 4	0
43. Clinton, Iowa	34	3	[3] 5	8	23. 6	0
44. Kansas City-Wyandotte County, Kans	185	8	D 24	32	17. 3	0
45. Jefferson County (Louisville), Ky	611	87	I 21	108	17. 6	63
46. Anne Arundel County, Md	207	27	(6)	27	13. 1	0
47. Baltimore, Md	939	77	(6)	77	8. 2	70
48. Baltimore County, Md	492	27	(6)	27	5. 5	0

Table I.—*Local air pollution programs and budgets*—Continued

City or area	Population 1960 (1,000)	Budget, 1965 ($1,000)			1965 per capita budget (cents)	1961 budget ($1,000)[2]
		Non-Federal	Federal[1]	Total		
49. Boston metropolitan area, Mass.[4]	1, 998	99	I 120	219	11. 0	52
50. Springfield metropolitan area, Mass.[4]	415	11	D 33	44	10. 6	0
51. Worcester, Mass	187	12	E 23	35	18. 6	0
52. Dearborn, Mich	112	16	0	16	14. 3	5
53. Detroit, Mich	1, 670	234	[7] 123	357	21. 4	180
54. Grand Rapids, Mich	177	10	0	10	5. 7	6
55. Muskegon County, Mich	150	5	D 16	21	14. 1	0
56. River Rouge, Mich	18	13	0	13	72. 3	0
57. Wayne County, Mich.[8]	996	43	I 90	133	13. 3	20
58. Wyandotte, Mich	44	9	I 18	27	61. 5	0
59. Minneapolis, Minn	483	29	I 38	67	13. 8	11
60. St. Paul, Minn	313	26	I 43	69	22. 1	0
61. St. Louis, Mo	750	134	I 43	177	23. 5	118
62. St. Louis County, Mo.[9]	704	69	E 105	174	24. 8	0
63. Omaha, Nebr	302	8	0	8	2. 6	20
64. Omaha-Douglas County, Nebr	343	10	[3] 21	31	9. 0	0
65. Clark County, Nev	127	50	0	50	39. 4	0
66. Reno-Sparks-Washoe County, Nev	85	13	E 28	41	48. 2	0
67. Camden, N.J	117	12	0	12	10. 2	7
68. East Orange, N.J	77	6	D 8	14	18. 2	0
69. Elizabeth, N.J	108	10	0	10	9. 3	0
70. Hillside Township, N.J	22	8	0	8	36. 3	5
71. Newark, N.J	405	66	0	66	16. 3	63
72. Perth Amboy, N.J	38	30	0	30	78. 9	13
73. Albuquerque, N. Mex	201	9	I 6	15	7. 5	0
74. Albany County, N.Y	273	2	D 3	5	1. 8	0
75. Broome County, N.Y	213	4	D 8	12	5. 5	0
76. Chemung County, N.Y	99	3	D 5	8	8. 1	0
77. Columbia County, N.Y	47	2	D 4	6	12. 7	0
78. Dutchess County, N.Y	176	2	E 3	5	2. 9	0
79. Erie County, N.Y	1, 065	38	D 76	114	10. 6	0
80. Mount Vernon, N.Y	76	3	D 5	8	10. 5	0
81. Nassau County, N.Y	1, 300	96	D 54	150	11. 5	0
82. New Rochelle, N.Y	77	6	E 6	12	15. 5	0
83. New York, N.Y	7, 782	1, 032	I 188	1, 220	15. 7	734
84. Niagara County, N.Y	242	12	D 35	47	19. 4	0
85. Rochester, N.Y	319	10	0	10	3. 3	10
86. Schnectady, N.Y	82	2	D 3	5	6. 1	0
87. Suffolk County, N.Y	667	8	[3] 23	31	4. 6	0
88. Syracuse, N.Y	216	50	0	50	23. 2	36
89. Yonkers, N.Y	191	5	D 9	14	7. 3	0
90. Interstate Sanitation Commission, New York and New Jersey	14, 700	36	[3] 42	78	0. 5	0
91. Asheville, N.C	59	21	0	21	35. 6	16
92. Buncombe, Haywood, Henderson and Transylvania Counties, N.C	222	8	D 25	33	14. 9	0
93. Charlotte, N.C	202	16	0	16	7. 9	19
94. Durham County, N.C	112	5	D 13	18	16. 1	0
95. Gaston County, N.C	127	7	D 19	26	20. 5	0
96. Guilford County, N.C	247	6	D 18	24	9. 8	0
97. New Hanover County, N.C	72	4	D 13	17	23. 6	0
98. Rowan County, N.C	83	4	D 13	17	20. 3	0

TABLE I.—*Local air pollution programs and budgets*—Continued

City or area	Population 1960 (1,000)	Budget, 1965 ($1,000)			1965 per capita budget (cents)	1961 budget ($1,000)[2]
		Non-Federal	Federal[1]	Total		
99. Winston Salem, N.C.	111	17	0	17	15.3	12
100. Akron, Ohio	290	36	D 94	130	44.8	16
101. Cincinnati, Ohio (area)[10]	542	97	0	97	17.9	165
102. Cleveland, Ohio	876	242	I 35	277	31.6	236
103. Columbus, Ohio	471	74	0	74	15.7	50
104. Dayton, Ohio	262	25	0	25	9.5	55
105. East Cleveland, Ohio	38	5	0	5	13.2	7
106. Lorain, Ohio	69	10	E 19	29	42.1	0
107. Toledo, Ohio	318	39	I 24	63	19.8	12
108. Youngstown, Ohio	167	18	0	18	10.8	17
109. Oklahoma City and County, Okla	440	3	D 10	13	3.0	0
110. Tulsa City and County, Okla	346	8	D 25	33	9.6	0
111. Eugene-Springfield, Oreg	71	16	0	16	22.5	10
112. Mid-Willamette Valley, Oreg.[11]	278	13	[3] 39	52	18.7	0
113. Portland, Oreg	373	45	I 73	118	31.5	17
114. Allegheny County, Pa	1,629	210	I 160	370	22.7	217
115. Erie, Pa	138	11	0	11	8.0	15
116. Lehigh Valley area, Pa	278	14	E 1	15	5.4	14
117. Philadelphia, Pa	2,003	241	I 125	366	18.2	166
118. Providence, R.I	207	36	I 7	43	20.8	31
119. Spartanburg, S.C	44	9	I 10	19	43.0	0
120. Chattanooga, Tenn	130	23	I 14	37	28.5	16
121. Nashville-Davidson County, Tenn	400	16	D 15	31	7.7	13
122. Harris County, Tex	1,243	40	0	40	3.2	42
123. Richmond, Va	220	29	0	29	13.2	25
124. Roanoke, Va	97	12	I 2	14	14.4	11
125. Seattle, Wash	557	35	0	35	6.3	12
126. Seattle-King County, Wash	935	56	D 38	94	10.0	0
127. Tacoma, Wash	148	12	0	12	8.1	8
128. Wheeling, W. Va	53	6	0	6	11.3	17
129. Green Bay, Wis	63	15	0	15	23.8	7
130. Milwaukee County, Wis	1,036	186	0	186	18.0	128
22 agencies existing in 1961 but not in 1965						308
Total[13]	[12] 63,362	10,673	3,581	14,254	22.6	8,177

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[1] U.S. Public Health Service program grant, unless indicated otherwise. E means "Establishment grant;" D means "Development grant;" and I means "Improvement grant."

[2] From reference 1.

[3] Funds are U.S. Public Health Service survey grant.

[4] Local program operated by the State.

[5] Serving unincorporated area only. Population is approximate.

[6] Participating in comprehensive survey of Baltimore metropolitan area, supported in part by $225,000 U.S. Public Health Service survey grant made to State of Maryland for all concerned agencies.

[7] Includes $80,000 U.S. Public Health Service survey grant funds.

[8] Not providing service in Detroit, which is part of Wayne County.

[9] Not providing service in city of St. Louis, which is not part of the county government.

[10] Includes $12,000 received from 8 communities for services provided by the city.

[11] Benton, Linn, Marion, Polk, and Yamhill Counties.

[12] Not the sum of the numbers in the column because of dual coverage of some areas.

[13] Since this list was prepared, additional cities are known to have started air pollution programs, including Monterey County, Calif.; Jefferson County, Colo.; Stamford, Conn.; York, Pa., and several neighboring communities; Kansas City, Mo.; Jersey City, N.J.; Fort Worth, Tex.; and Dallas, Tex.

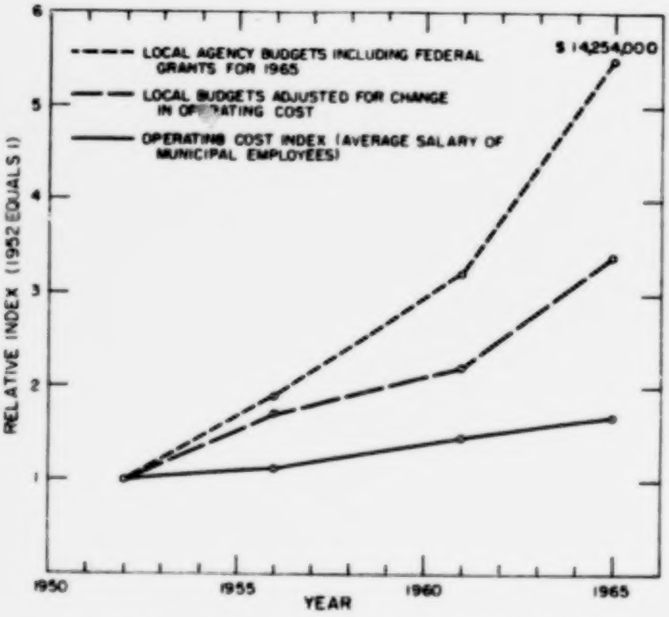

FIGURE 1. Budgets of local governmental air pollution control agencies.

for a total of $14.3 million available to local agencies.

Trends in Local Governmental Air Pollution Program Budgets

Total budgets of local air pollution control agencies have increased steadily since 1952[1, 3, 4] (Table II and Figure 1). Budgets in 1965 were more than four times those in 1952 and, including Federal grants, funds available to local agencies were 5.5 times those available in 1952. Agency operating costs have also risen steadily, as indicated by the average salary of municipal employees[5] (Table II and Figure 1). The cost index, based on 1952 salaries equaling 1.00, rose to 1.68 in 1965. Thus, the real increase from 1952 to 1965 is a factor of 3.4 instead of 5.5. Even with this operating cost adjustment, total funds available increased more than 50 percent from 1961 to 1965, with much of the increase being attributable to the infusion of Federal grant funds.

The per capita budgets of local agencies did not change much between 1952 and 1961, but Federal grants resulted in a marked increase in 1965 (Figure 2 and Table III). There has been a decline in the percentage of agencies having a per capita budget of less than 10 cents and an increase in the percentage of agencies with per capita budgets of 20 cents or more. In view of the estimate that a per capita budget of about 40 cents is required to operate an adequate comprehensive program, much more expansion of local programs is obviously needed.

When expenditures of local agencies are viewed in the light of total urban population, and in view of rising operating costs, the situation is even less satisfactory. While local agency budgets and per capita expenditures have both increased, so has the total urban population. Much of the increase in urban population has occurred in suburban areas where there is often no air pollution control agency providing services. Many local agencies serve only the central city of a metropolitan area. Figure 3 and Table II show that on the basis of total urban population, per capita expenditures by local agencies, including Federal grants, were only 10.6 cents in 1965. When adjusted for rising operating costs, this is only 2.4 times what it was in 1952. These data indicate that about a fourfold increase above 1965 expenditures is needed to reach a level of 40 cents per capita for the urban population.

Table II.—*Budgets of local governmental air pollution control agencies adjusted for population growth and operating costs, 1952–65*

Descriptive item		Year			
		1952 [a]	1956 [b]	1961 [c]	1965
1. Budgets of local agencies [d]	($1,000)	2, 589	5, 018	8, 177	10, 673
2. Federal grants to local agencies	($1,000)	0	0	0	3, 581
3. Total funds (lines 1 + 2)	($1,000)	2, 589	5, 018	8, 177	14, 254
4. Operating cost index [e]		1. 00	1. 12	1. 44	1. 68
5. Total funds, cost index adjusted (line 3 ÷ 4)		2, 589	4, 480	5, 678	8, 485
6. Total U.S. urban population	(millions)	102	111	127	135
7. Budget per capita for urban population (line 3 ÷ 6).	(cents)	2. 6	4. 5	6. 4	10. 6
8. Budget per capita, operating cost adjusted (line 7 ÷ 4).	(cents)	2. 6	4. 0	4. 5	6. 3

[a] From reference 2.

[b] From reference 3.

[c] From reference 1.

[d] Including State operated local programs in the Boston area and in Polk-Hillsborough Counties, Fla. (1961), and also in the Springfield, Mass., area (1965).

[e] Average salary of municipal employees in the United States as an index, with 1952 equal to 1.00. From reference 4.

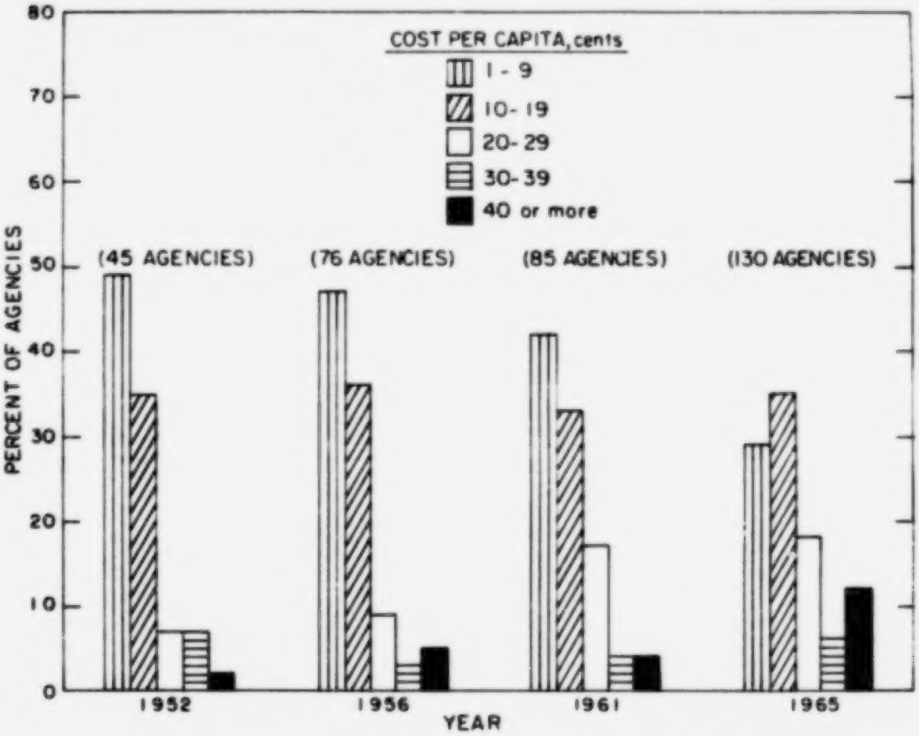

Figure 2. Per capita budgets for local air pollution control agencies, 1952–1965.

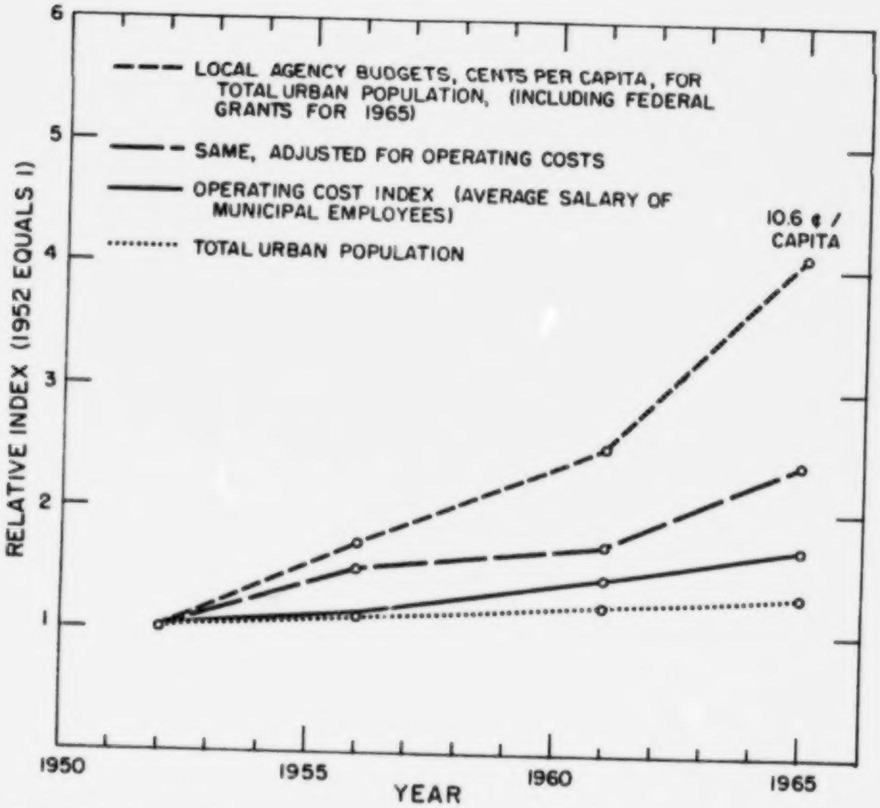

FIGURE 3. Per capita budgets of local governmental air pollution control agencies relating to total urban population.

TABLE III.—*Per capita expenditures of local air pollution control agencies*

[Agencies spending $5,000 or more]

Annual expenditures per capita (cents)	1952 [a]		1956 [b]		1961		1965	
	Number of agencies reporting	Percent of agencies	Number of agencies reporting	Percent of agencies	Number of agencies reporting	Percent of agencies	Number of agencies reporting	Percent of agencies
1 to 9	22	49	36	47	36	42	38	29
10 to 19	16	35	27	36	28	33	46	35
20 to 29	3	7	7	9	14	17	23	18
30 to 39	3	7	2	3	3	4	8	6
40 to 49	0	0	4	5	2	2	5	4
50 to 59	0	0	0	0	2	2	5	4
60 or more	1	2	0	0	0	0	5	4
Total	45	100	76	100	85	100	130	100
Median	10.0		10.0		10.8		15.2	

[a] Reference 2. [b] Reference 3. [c] Reference 1.

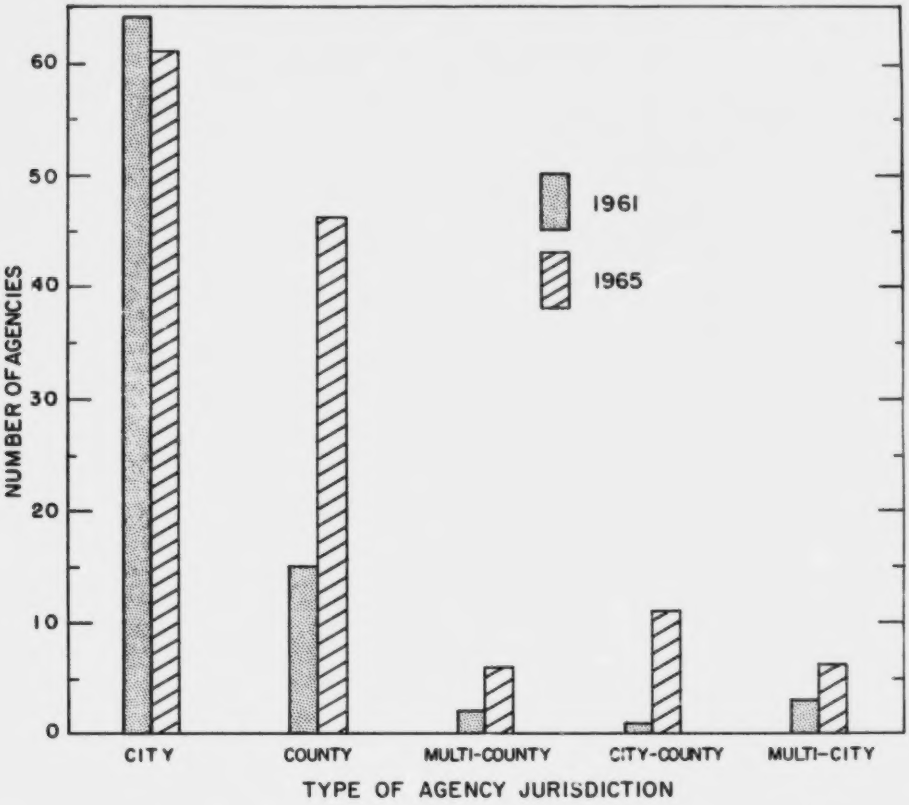

FIGURE 4. Types of jurisdictions served by local air pollution control agencies—1961 and 1965.

Programs in Major Urban Centers

Air pollution is most likely to be of major concern in large urban centers. There are 24 Standard Metropolitan Statistical Areas with a population of 1 million or more. In 1965, these 24 areas contained about 69 million people, about half the total urban population. They have increased in population by about 8 percent since 1961. All but one of these areas had some sort of air pollution program in 1965. In 18, the program budget was 5 cents per capita or more; however, only 72 percent of the total population of these metropolitan areas was served by a program spending 5 cents per capita or more. On the basis of total population of these 24 areas, total per capita budgets were, however, only 16 cents in 1965. In some urban centers, only a small percentage of the population is covered by a central city program, e.g., 16 percent in Kansas City; 32 percent in Washington, D.C.; 45 percent in Cleveland; and 64 percent in Philadelphia. On the other hand, Standard Metropolitan Statistical Areas made up of one county and served by a county-wide control program have all people covered; therefore, increased effort should be made to provide for air pollution control on a metropolitan area basis.

In 29 Standard Metropolitan Statistical Areas with populations of 0.5 to 1.0 million, containing some 23 million people, only 55 percent of the population was served by a control program with a budget of at least five cents per capita. In 8 of the 29 areas, none of the population was served by even a minimum program. A total of $2.1 million was budgeted by local and certain State control agencies and Federal grants. The average per capita budget, based on total metropolitan area population, was 8.9 cents and ranged from 0 to 32.8.

TABLE IV.—*Organizational patterns of local air pollution programs*

Type of jurisdictional area	Department in which air pollution control is located												1961 [b]	
	Health department		Separate agency [a]		Building department		Safety department		Other departments		Total			
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1956 [c]														
All types	23	28	16	20	19	23	0	12	14	17	82	100	....	....
1965 [d]														
Cities	20	33	13	21	8	13	9	15	11	18	61	47	64	75
Counties	34	74	10	22	2	4	0	0	0	0	46	35	15	18
Multicounty	3	50	2	33	0	0	0	0	1	17	6	5	2	2
Multicity	3	50	2	33	0	0	1	17	0	0	6	5	3	4
City-county	8	73	0	0	0	0	0	0	3	27	11	8	1	1
All types spending $100,000 per year or more.	14	52	8	30	2	7	2	7	1	4	27	100	....	....
All types newly created since 1961.	54	81	6	9	2	3	0	0	5	7	67	100	....	....
All types	68	52	27	21	10	8	10	8	15	11	130	100	85	100

[a] Head of air pollution agency reports to administrative head of government or independent board or commission responsible directly to the head of government or the public.

[b] Reference 6.

[c] Derived from table 1 and various other sources.

[d] From reference 1.

ORGANIZATIONAL ASPECTS OF LOCAL GOVERNMENTAL AIR POLLUTION CONTROL PROGRAMS

Jurisdictional Areas of Local Programs

Until the late 1940's cities operated nearly all of the local air pollution control programs. In 1961, three-fourths of all local control agencies were in city governments[1] (Table IV and Figure 4). In the late 1940's, California authorized counties to operate air pollution control districts. By 1961, seven such districts had been formed, including the six-county San Francisco Bay Area district. In 1952, Kentucky authorized county districts, and by 1961, two had been formed (Jefferson County-Louisville, and McCracken County-Paducah). County programs were also operated by five county health departments (Allegheny County, Pa.; Philadelphia, Pa.; Harris County, Tex. (Houston); Dade County, Fla. (Miami); and Wayne County, Mich., serving all but the City of Detroit). Milwaukee County and the City and County of Denver also operated programs in 1961. Other multijurisdictional arrangements existing in 1961 were the Polk-Hillsborough County district operated by the State of Florida; the metropolitan Boston district (28 cities) operated by the State; the Cincinnati intercommunity program (8 cities) operated by Cincinnati; the Lehigh Valley, Pennsylvania air pollution control agency (5 communities); and the Dayton-Montgomery County (Ohio) contract services arrangement.

By 1965, the situation had changed markedly (Table IV and Figure 4). The number of city programs decreased by three from 1961 to 1965. The number of county programs, however, increased from 15 in 1961 to 46 in 1965. In 1965, county, multicounty, and city-county programs made up 48 percent of the total number of local programs. All but four of the new county, multicounty, and city-county programs were initiated by previously existing health departments. In North Carolina, four counties (Buncomb, Haywood, Henderson, and Transylvania) with a total population of 228,000 had entered into an agreement to develop an air pollution program to serve their entire area. In Oregon, five counties (Benton, Linn, Marion, Polk, and Yamhill) with a total population of 295,000 had formed the Mid-Willamette Valley Air Pollution Control Authority to develop basic data upon which to establish a regional air pollution control program. The City of Toledo, Ohio, had agreements with surrounding Lucas County to provide air pollution services in the unincorporated parts of the county and with one other municipality, both on a contract basis. Akron and Barberton, Ohio, were operating a coopera-

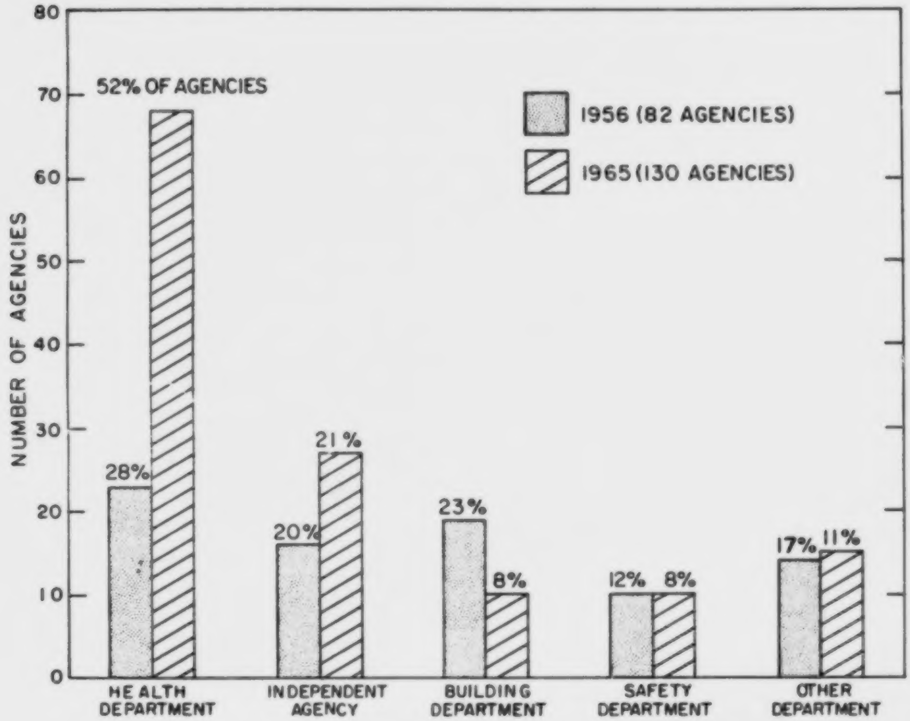

FIGURE 5. Organizational placement of air pollution control agencies in local governments.

tive program, as were Springfield and Eugene, Oregon. Cook County, Illinois, was operating a program in the unincorporated parts of the county. Even with this program and the City of Chicago program, however, more than 25 percent of the total county population was without program services. The State of Massachusetts was in the process of developing a program for 12 communities in the greater Springfield area. The State of Maryland, in cooperation with the City of Baltimore and Anne Arundel and Baltimore counties, was conducting a comprehensive study in the greater Baltimore area. The Interstate Sanitation Commission (New York and New Jersey, with Connecticut abstaining) was conducting limited studies in the New York City-New Jersey metropolitan area. The Metropolitan Washington Council of Governments, in cooperation with State and local governments, was conducting a study directed toward evaluation of the air pollution problem in Metropolitan Washington, with a view toward recommending means for air resource management. In the Denver metropolitan area, a nonprofit corporation known as the Regional Air Pollution Control Agency had been formed by representatives of city and county governments in the five-county area (Adams, Arapahoe, Boulder, Denver, and Jefferson). The agency is to promote cooperative action on the part of governments in the area on the establishment and operation of air pollution prevention and control programs.

All of these interlocal arrangements and the trend toward county programs indicate a recognition of the regional nature of air pollution problems and increased efforts to mold governmental organizations and programs to better cope with the problems at hand. To date, however, only three of our ten largest cities are part of a regional program and less than half of the 50 largest cities are included in regional programs. We still have a long way to go in providing appropriate jurisdictional arrangements for air pollution control in major urban centers.

Placement of Air Pollution Control in Local Governmental Structure

In 1956, air pollution control activities were widely dispersed in various departments of local government, with health and building departments being most common[6] (Table IV and Figure 5). In 1965, there was still fairly wide distribution, but the highest percentage of the local agencies was in health departments (52 percent). Another 21 percent of the agencies was independent of other city departments, an increase from 16 such agencies in 1956 to 27 in 1965. The number of agencies in building departments decreased from 19 to 10. The number of agencies in safety and miscellaneous other departments changed by only one (24 in 1956 and 25 in 1965). There was little difference in 1965 in organizational placement of air pollution control agencies between the large agencies (spending $100,000 or more) and the total group of agencies. In both classes, 52 percent of the agencies are in health departments and 30, or 21 percent, are independent agencies. The agencies created in the period 1961 to 1965 are, however, predominantly in health departments (54 of 67, or 81 percent). Six new independent agencies came into being, and seven were created in other departments.

State Regulatory Activities

In addition to regulatory activities of local governments, some States, in recent years, have undertaken activities that have the same effect as local programs. In 1961, only Oregon, Delaware, Hawaii, New Jersey, and Pennsylvania were engaged in such regulatory activities.[1] All five programs were very modestly funded, and regulatory activity was limited. In addition, Florida and Massachusetts each operated one local program in a specific limited area. By 1965, Illinois, Indiana, New York, and West Virginia had also entered into regulatory activity in one way or another. In Hawaii, New Jersey, Oregon, Pennsylvania, and West Virginia, regulatory activity was at a significant level.

In addition, the regulatory activity of California, and to some extent, New York, in the motor vehicle pollution control field was having a significant effect on local programs in those States.

In Arkansas and Louisiana, State laws were enacted to place total responsibility for air pollution control with the State government, precluding local governmental programs.

The nature and extent of State programs and their policies toward local programs will have an important bearing on local programs. The relationships between State and local responsibilities must be carefully developed and implemented so that the activities of the two levels of government augment each other in the best ways possible.

STATUS OF LOCAL PROGRAM OPERATIONS

Establishment of Public Policy

A key element in any governmental program is a clear statement of public policy—an expression of the central ideas and purposes that guide the public actions of individuals and social institutions, both public and private.[7] Desirably, the top elected officials in our communities, after appropriate community involvement in development of a policy, should proclaim public policy and then provide the leadership to see that the policy is carried out. Although more and more public officials are making such declarations, many communities still do not have a public policy concerning the air resource.

The establishment of precise statements of public policy in the air resource field is deterred by several factors. For one, the relationships between adverse effects of air pollution and pollutant concentrations have not been clearly and unequivocally delineated in specific terminology. For another, policy makers and the public are having difficulty grasping the significance of the population, urbanization, and energy-use explosions of the present and especially of the future. Another factor is that the jurisdictional area of policy makers in local government is not large enough to encompass the air basin for which policy has to be made. Still another is the disparity that may exist between those who pay for the costs of pollution control and those who benefit from the control. These are formidable obstacles to be sure, but they are not insurmountable. In spite of these impeding factors, policy must be (and is being) made to form a basis for current efforts. Modifications and specificity can be incorporated as more information becomes available and as policy-making obstacles are overcome.

Staffing of Local Air Pollution Control Programs

In 1961, about 1,000 people of all types were employed by local air pollution control agencies.[1] Current budgets indicate probably around 1,600 positions in local agencies. This large increase in staff, and expansion of Federal, State, and industrial activities has created a major problem in recruitment and training of personnel for local agencies, as well as for other organizations engaged in air pollution control work. A recent survey indicated that about 15 to 20 percent of the positions in State and local governmental air pollution control agencies were vacant. Local agencies have had especially difficult recruiting problems because of low salary schedules, a problem that must be corrected if local agencies are to succeed.

Training opportunities exist and are reasonably adequate, although oversubscription for the short-term technical training courses conducted by the Public Health Service has delayed training in some specialty areas. Efforts are being made to improve this situation.

Establishing Air Quality Goals

Ambient air quality goals (or objectives or standards by whichever name identified) are the keystone of air resource management. They describe the air quality to be achieved or preserved—the end to which control measures are directed. As important as air quality goals are, however, only a few jurisdictions have adopted them. This deficiency should be corrected as soon as possible.

It seems clear that air quality goals will be more widely adopted in the coming years. Nearly everyone agrees they are needed. Reluctance to adopt them has been due largely to the shortage of information upon which to base goals of desirable air quality, but this situation is continually improving as a result of accumulated research findings. The Federal Clean Air Act directed the promulgation of air quality criteria, some of which are to be published very soon. The effect of adopting air quality goals will probably be an acceleration of efforts to meet them by increasing control of emissions.

Air Quality Measurement

Activities directed toward determination of the concentrations of common air pollutants have been a major part of many of the newer air pollution control programs. Many older programs have increased their efforts in this field. In a broad sense, local agencies are probably doing a better job on this aspect of their programs than on any other. Continuing problems persist, however, in achieving satisfactory operation of more complex instrumentation because of equipment which has only marginal capabilities and the lack of fully qualified operating personnel. The number of pollutants measured should also be increased. This is likely to occur as agencies grow in their level of sophistication and instrumentation is improved.

Pollutant Emission Inventories

The preparation of an inventory of pollutant emissions and pollutant sources is a desirable preparatory step in development of an air pollution control plan. Generalized inventories can be prepared rather easily on the basis of readily available information on activities which cause pollution in a community and on pollutant emission factors. Most local programs have prepared such inventories; however, before a full-fledged abatement program can proceed, specific information is needed on the location and characteristics of all important air pollution sources. Gathering comprehensive source data requires extensive field inspection work, and only a few of the newer agencies have advanced to this stage of development. Some of the older agencies still have not obtained or organized complete information on the sources of pollution within their jurisdiction. This program element requires considerable attention in future activities.

Knowledge of Effects of Air Pollution

Local air pollution control agencies are generally in poor shape with respect to information on the detrimental effects caused by air pollution within their jurisdictions because studies of these matters are expensive and require highly qualified personnel not normally available within local agencies. Another deterring factor is the lack of clear-cut information on relationships between pollutant concentrations (which local agencies generally know) and some detrimental effect.

Some agencies have obtained information on effects from research projects conducted by universities in their area. It seems appropriate for local agencies to stimulate such projects. Some localities have been included in broad-scale studies of effects conducted by the Public Health Service, and a few local studies of certain effects have been done. It is apparent, however, that increasingly better demonstrations of the adverse effects of air pollution will be required to justify the higher costs of more restrictive pollutant emission control programs. All levels of government should contribute to this effort. The Federal Government will probably make the most extensive contributions to improving the situation in a general sense, but local agencies will have to adapt and interpret the results of Federal and other work to their particular situations and conduct certain specific studies of their own.

Design and Implementation of Abatement Programs

With knowledge of pollution levels, sources of pollution, and certain other information, a plan can be prepared for reducing pollutant emissions to levels needed to satisfy air quality goals. The plan is implemented through emission control ordinances or regulations and their enforcement. The status of this aspect of local programs is far from satisfactory. Some of the newer agencies have not yet adopted any emission control regulations, and some that have, do not have adequate staff or public support to enforce them. Some of the regulations that have been adopted cannot be expected to provide adequate air quality, even if full compliance were achieved. Among the older agencies, emission control regulations are obsolete in many cases and even some of the more recent revisions are not restrictive enough to ensure adequate air quality. Enforcement activities are generally hampered by insufficient staff, lack of emission testing capability, and unavailability of skilled legal assistance for prosecution of recalcitrants.

The situation in general is unsatisfactory; but a few recent instances of modernization of ordinances and regulations appear to provide for sufficient emission control to result in clean air, and a number of agencies are operating vigorous programs to bring about compliance. Hopefully, these few leading communities will provide an example sufficient to encourage others to move ahead.

Public Information Activities

Community recognition of air pollution problems and an action program to resolve the problems will come about much more readily when the public is convinced that problems exist, that the problems concern them, that the problems can be solved, and that they are problems the public wants to have solved. Any governmental program will be about as good as the majority of the people want it to be; therefore, a public information and education program is a vital part of a governmental air pollution control program. In spite of these generally accepted facts, very few air pollution control agencies have a public information program at all, and even fewer employ even one public information specialist. Only a few agencies distribute an annual (or other periodic) report to inform the public of their activities. Public information and education need much more attention at the local level.

Long-Range Program Plans

Long-range planning should be an integral part of any local air pollution control program. Planning helps smooth the way for anticipated social and technological changes in the urban environment and makes it possible to consider a much broader scope of alternative programs to achieve or maintain good air quality. Long-range plans also force program directors to think ahead about technological changes and predispose them toward changes they can agree to and support. Without planning, the director will find himself reacting to changing events rather than influencing them beforehand as he should.

In general, the actions currently being taken by local programs are directed toward abatement of neighborhood nuisances and application of readily available emission control equipment and procedures to existing and new sources. Little consideration is being given to what the situation will be in 1990, when our population will be nearly half again what it is now. Rather sweeping changes in pollutant emissions are going to be necessary if we are to have adequately clean air to breathe at that time. Our current activities can be classified as short-range, stop-gap measures, when viewed in the long-range picture. When we consider that sweeping changes take five years to plan and ten or more years to implement, the need to accelerate long-range planning and to start certain long-range actions becomes very urgent. Local agencies in the major urban centers must initiate and accelerate their long-range planning programs.

SUMMARY

Local air pollution control agencies have carried out the majority of the regulatory activities in air pollution control in the past and will probably continue to do so in the future. Local program activity has expanded substantially in recent years, especially since Federal grant funds became available in 1965. Additional expansion, to perhaps four times current activities, is needed. Particular attention is needed to extend air pollution control activities throughout the areas of major urban centers where the current activities are confined to the central cities. Staffing of local agencies will be a continuing problem until salary schedules can be improved and the pool of trained manpower can be expanded. There is a need for greater attention to enunciation of public policy by top community officials and establishment of air quality goals. Air quality measurement and generalized pollutant emission inventories are proceeding fairly well; but air quality measurements should include a wider range of pollutants, and specific, detailed information on pollutant sources should be more generally obtained and organized. Information on detrimental effects of pollution is usually less than adequate and in some communities is extremely inadequate. Design and enforcement of emission control programs by local agencies are satisfactory only in a few areas. Many emission regulations are too lenient to ensure adequate air quality, and enforcement efforts are generally far short of needs. Long-range planning, an important program element, is generally neglected and must soon be improved.

Local air pollution agencies have begun to carry out their responsibilities, but effort put forth thus far constitutes only a beginning. There is still a long way to go.

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". . . Mayor of Cleveland . . . chairman of Committee on Natural Resources for the National League of Cities . . ."

THE CASE FOR A LOCAL OR REGIONAL AIR POLLUTION CONTROL PROGRAM

RALPH S. LOCHER
Mayor of Cleveland, Ohio

I am honored to participate in this important and significant Conference on Air Pollution, and to present in this panel the case for a local or regional air pollution control program.

The annual meeting of the National League of Cities has just been concluded. As chairman of the Committee on Natural Resources of the National League of Cities, I consider it significant that the official policy of the League stresses great concern over the problem of air pollution. It should also be noted that the National League of Cities urged the Secretary of Health, Education, and Welfare to hold this national conference to focus attention on air pollution, one of the most serious challenges facing this generation.

The City of Cleveland has long recognized the need for a vigorous local enforcement program. It established a Smoke Abatement Bureau as long ago as 1881. Since that year, we have spent much time, energy, and thought in carrying on the fight against this most pressing urban problem.

There was a time in our country's history when one could pack up his belongings and family and move on to a new virgin area if the old environment became too crowded, too depleted, or too befouled. This freedom is long past. Our destinies have become tied to the urban complex; it is difficult, if not impossible, to run away from the problem of air pollution. We must bring about a degree of accommodation between man and his environment if we are to make our lives and those of our chlidren livable in a healthful atmosphere.

Today, there are about 195 million people living in the United States. Some 137 million of these can be found within our great urban centers. However, when we discuss the problem of air pollution, it becomes necessary to supplement this figure with a large number of additional persons living within the pollution fallout pattern. Air pollution knows no political boundaries. It will engulf adjacent suburban and rural areas through the medium of prevailing winds.

Further, it has been estimated that by the year 2000, there will be 324 million persons living within the United States. Some 275 million of these will live within the great megalopolitan centers. Another 32 million will reside within contamination range. As more and more people become involved, the causes and effects of pollution will demand, and hopefully receive, more attention than has been expended to date.

Air pollution is becoming one of the major plagues of history. It can be compared, in many ways, with a more infamous predecessor of the 14th century which almost destroyed urbanism. Like this predecessor, the plague is to be found at its worst in the crowded urban environment; like the earlier plague, its retention and spread are caused primarily by the concentration of these people; and like its predecessor, it is described in dark hues. Unlike the earlier plague, it is possible for pollution to be controlled effectively by man and made harmless before it makes serious inroads into modern-day urban life.

It is estimated that the average adult breathes 6,000 gallons of air daily. Included are some 10 billion particles of foreign matter. Most particles are harmless. However, with the increased incidence of smog and inversion, as well as with numerous less noticeable, but ever-present, noxious elements, much of this foreign material harmful to the human respiratory system will take its toll. As pollution increases, so does the foreign matter, and so does the incidence of harmful direct and indirect injury to the human body.

We have placed the following warning on packages of cigarettes: *Caution: Cigarette smoking may be hazardous to your health.*

It is becoming increasingly apparent that past generations have been poor stewards of our natural resources; and with an apology to the present generation, we should label the air we breathe: *Caution: The air you are breathing may be hazardous to your health.*

The economic side-effect of air pollution also must be considered. It is estimated that annually air pollution costs the national economy $11 billion, or $65 for each man, woman, and child. Needless to say, this is far more than we are spending to combat the problem. Cleveland spends only 27 cents per capita, and that is relatively high. The harm can be visually seen in the form of damage to crops, clothing, home furnishings, buildings, machinery, and public installations.

I will not delve into the historical aspect of pollution, which is well known by all present here today, except to point out that air pollution is not a new problem; it can be traced back to the time of the Romans. Nor is it any longer a purely local problem, as witness the recent eastern seabord crisis.

Too little has really been done! Too much has yet to be done!

A step in the right direction was made by the Federal Government with its advance into the battle, with a commitment spelled out by the 1963 Clean Air Act as amended in 1965 and 1966.

Still, too little is being done. Sums of 5, 6, 7 million dollars annually to assist *all* local agencies engaged in the war on air pollution activities are but a halting faltering first step. The annual sums allocated would hardly be sufficient to build one mile of highway in any of our major urban areas.

Fortunately, much of the original appropriation is being well utilized to increase the research, training, and technical assistance phases of the anti-air pollution program.

Of particular significance is the Federal Government's research on the automobile as a contributing factor to the pollution problem. It is within this and similar fields that the Federal Government can make a really significant contribution.

The authority given to the Federal Government by the 1965 amendments will strengthen the program with regard to enforcing the law and providing funds for the support of enforcement.

However, the Federal Government is only a partner. State and local agencies must institute new effective controls and strengthen the ones they now have at their disposal.

What are our prospects, if we do not vigorously enforce controls and standards?

Our urban centers, which we are trying hard to revitalize through various programs, will become the centers of large, noxious gray clouds. As I have said, not only will the urban area itself be covered, but so will the less populated suburban and rural areas which are so unfortunate as to be within the prevailing wind patterns. The incidence of respiratory and skin diseases is very likely to increase to serious proportions as will other harmful side-effects now suspected to be triggered or nurtured by the more serious elements to be found in smog and inversions—and in our everyday urban air.

The conservationists tell us of one of these side-effects. The average temperature will rise as more carbon dioxide is pumped into the air and there is less vegetation, a result of increased urbanism, to absorb this otherwise essential but minor element of the air we breathe. The average temperature is estimated to have increased eight degrees over the past half-century and is expected to advance even further unless a means of effective control can be brought about.

While the Federal Government can nurture the clean air program, it will not be able to undertake the vigorous action necessary to actually control and monitor air pollution in our urban centers. This has been and of necessity will be, a function of local agencies on either a municipal or regional basis. . . . with vigorous Federal support.

Before exploring this, however, let us look briefly at the States and their role in pollution control. Generally, the States have ignored or have underplayed the problem. Although the first State action was taken in 1952, to date less than one-half of the State governments have enacted anti-air pollution legislation. In my own State, Ohio, the municipal local governments possess regulatory jurisdiction through constitutional home rule provisions. The State of Ohio may also assert jurisdiction where the problem is of general statewide concern. The problem of air pollution clearly is of general statewide concern. California has been the exception in research dealing with chemical emissions of automobile pollutants.

In the war on air pollution, the States must take the lead in adapting national research and standards to specific conditions and in monitoring the efficiency and effectiveness of local techniques and enforcement.

The States also should provide substantial supplementary research through their universities by funding projects within the area of air pollution. Needless to say, the funding of programs on a matching basis would also be a significant step toward assisting local agencies in meeting their obligations.

Even with the full support and cooperation of the Federal-State partnership, the anti-air pollution battle cannot be won without the local agencies. Air pollution is a creation of the urban environment. The local urban agency is the best and most logical enforcer of standards and regulations at this level.

Local control is necessitated by many factors. Among these, I might cite the following:

1. In most large urban centers where air pollution exists on a noticeable scale, there already is a small band of dedicated professionals who are aware of the pollution problem and many, if not most, of the techniques needed to combat this problem. They need not be supplemented nor supplanted by new organizations. They need to be supported through guidance, sufficiently large budgets, and modern equipment.
2. Pollution is an environmental health problem and as such needs to be coordinated with the many varied local programs in that field carried on today. We in Cleveland have recognized this and have reorganized our Air Pollution Division within the Department of Public Health and Welfare.
3. The physical situation can be best controlled locally. As such, planning becomes a prime consideration in the location of industry and of apartments (with their incinerators), and in the placement of residential areas. This purely local function must be coordinated and integrated with the environmental health.
4. Citizen support, recognized by all as a key to the advancement of anti-air pollution programs, can best be fostered on a local and more personalized basis. In conjunction with this, let it be remembered that municipal officials are among the most sensitive to citizen pressure, for we are closest to the electorate. As such, local officials are perhaps the most responsive group to heed the desires and needs of our people. And it is the local governments which have stepped into the field and which have already established some programs to deal with the problem. We should, therefore, think in terms of strengthening these ongoing and func-

tioning agencies instead of weakening them by the establishment of new special entities.

5. *Finally*, the ferreting out of violations and the time-consuming followup needed to correct and control air pollution are better suited to a local function.

Where "locally" should the enforcement agency be placed? I favor the city.

This governmental body has a professional staff in most instances. It is usually the prime site of the majority of those who pollute the air. And it has an effective voice, through its strong national association, to call attention to the problems and press for assistance.

But this is a regional problem! Yes, but we are looking for the most efficient location to place an effective controlling unit. The city, as I have stated, has the professional manpower, techniques, equipment, and resources to provide the nucleus of an effective control. The city is a "responsive agency." That is, unlike a regional authority, it is answerable and sensitive to the people. The city already exists. Therefore, another new governmental unit would not have to be created. We have been witnessing too much Federal and State encouragement of functional fragmentation on the local level. The city, in the great majority of instances, is equipped to handle the problem of air pollution where our more archaic cousin—the county—cannot.

If we decide upon the city, which city?

Perhaps I am unduly prejudiced in this matter, but I answer: the central city. In our metropolitan area, only the City of Cleveland maintains an active function concerned daily with air pollution. Of the remaining 61 communities within Cuyahoga County, all suburban, only three have any legislation and only one has an advisor on the problem.

If we decide upon the central city, how can it combat the regional aspect that air pollution presents?

First, let us recognize quite frankly that the majority of those who pollute our air are to be found in the central cities. These include the bulk of heavy industry, apartment houses with their incinerators and their older and less efficient heating units, and the concentration of converging automobile traffic. Enforcement of local and State laws within the central city would have a great effect upon cutting materially the "regional" aspect of pollution. For instance, if Boston, Providence, New York City, the major New Jersey cities, and Philadelphia could control the emission of noxious elements and smoke, the eastern seaboard would be well on its way to being a clean air area.

Second, several States have allowed their cities extraterritorial powers in relation to planning. Perhaps we should explore this concept in greater detail, with the thought of giving the central city such power as is necessary to control the problem of increased air pollution in the suburban areas.

Another, and probably more acceptable, approach would be the creation of a Federal-State subsidized and encouraged incentive plan for suburban communities to participate with the central cities in a program of control. And, of course, the States should be urged to enact statewide standards and provide financial support to the program to be enforced by the local governments.

For example, let us assume that the Federal Government, through funding and the State government, through legislation, set a series of minimum standards that must be met to combat air pollution. First, the State would set criteria and then inspect local communities to determine if pollution levels exceeded these standards. Those communities which surpassed the minimum criteria and were thereby pinpointed as contributors to the metropolitan air pollution problem would be required to act, under threat of fine.

Two avenues of enforcement would be open. The first would be without the incentive of matching Federal-State funds, but would allow the smaller communities to establish their own air pollution agencies to enforce the State standards. The second, and hopefully more reasonable, avenue would be to have a Federal one-third and State one-third matching fund to communities which joined the central city through contract to enforce pollution control within the metropolitan community.

Regardless of the specific solution, there has to be a coordinated approach by the

Federal, State, and local agencies, with the enforcement function embodied in the latter.

As previously mentioned, there are only limited measures available within the Cleveland metropolitan area outside of the central city. Yet, some of our air pollution does stem from industrial enclaves and new cities which are outside of our enforcement area. An extension of our authority and assistance through extraterritorial powers or through contract would be most desirable for all concerned for the control of pollution. At present, there is no other agency in the metropolitan Cleveland area as well staffed or as technically competent as the City of Cleveland. If we are to be effective, changes must be made, and they must be made soon.

CONCLUSION

Let us look to the future. Let us hope that we will have been wise and shrewd enough to have cleared away this growing plague-like cloud so that we can indeed profit by the joys and benefits of urban living.

Specifically, let me urge a partnership

- —With the Federal Government providing funding, research, leadership.
- —With the State government providing funding, sound legislation, community standards.
- —With the Central City providing funding, technical expertise, effective enforcement.
- —With the suburban city providing support to the enforcement program in concert, or by contractual participation with the central city.

All four partners are needed, for it will take all to do the job that must be accomplished if we are to have clean air and healthful communities.

I especially urge an enlarged role for the central city, which is the real focal point of pollution. Let us use the resources that we have and use them wisely. We do not need more governmental units, more barriers, more confusion, nor more apathy. We do need more and cleaner air for the urban environment and its inhabitants.

We must look for new means of research, new legislation, and for new methods of control.

As a representative of a city that is very much concerned about the problems presented by air pollution, I plead for assistance and, as its representative, I pledge my support to bring about our desired goal: cleaner air for our citizens.

I conclude with this admonition—in the fight for clean air—it is later than we think!

". . . sanitary engineer . . . director of sanitation and director of environmental health for Richmond . . . over ten years supervising St. Louis environmental health program. . . ."

DEVELOPING AND ESTABLISHING NEW LOCAL OR REGIONAL AIR POLLUTION CONTROL PROGRAMS

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For the past three and one-half years the metropolitan St. Louis area has been engaged in the development of an air management program. Through some of the experiences we have had during this period in attempting to develop the program, you may find assistance in similar situations.

The St. Louis metropolitan area is well known for a variety of accomplishments: for its production of shoes, beer, automobiles, space capsules; for having the second oldest symphony in the United States; for being the city that financed Charles Lindbergh's flight. This metropolitan area, one of the oldest in the country, with its rich heritage of the steamboat era and its role in the development of jazz, is undergoing a face-lifting. The new "Spirit of St. Louis" is widely acclaimed. Busch Memorial Stadium and the Gateway Arch are outstanding symbols of the city's revitalization. Yet one visible remnant of the past still blots the picture of the new St. Louis—one of the worst air pollution problems in the United States.

Although today's air pollution is generally associated with current technological developments, metropolitan St. Louis has historically been plagued with a contaminated atmosphere. Even before the turn of the century, Mark Twain wrote in *Pudd'nhead Wilson*, "The Friday after election was a rainy one in St. Louis. It rained all day long and rained hard, apparently trying to wash that soot-blackened town white, but, of course, not succeeding." Where nature could not succeed, St. Louisans tried. In 1893 St. Louis passed its first smoke ordinance. In the next 44 years, eight more smoke ordinances were adopted, but each effort resulted in very little improvement.

In 1937, the city of St. Louis passed an ordinance creating a division of smoke regulation. This ordinance was strengthened in 1940 and eventually the black smoke that had always enveloped the city became a part of the past. Smoke abatement dealt with only one part of the problem. Other contaminants were abundant in the city air. The battle against air pollution was certainly not won. St. Louis County, Missouri and East St. Louis and Granite City, Illinois have since passed similar ordinances, all of which are inadequate. They all lack proper emission limitations.

In 1962, with the guidance of the U.S. Public Health Service, a renewed interest in air pollution developed in metropolitan St. Louis. From this revival of interest grew the Interstate Air Pollution Study, which will ultimately result in a comprehensive program for the metropolitan area. For the past three and one-half years the metropolitan St. Louis area has been engaged in developing an air pollution control program tailored to fit the needs of the community. I would like to share with you our experiences in the development of an air resource management program for the metropolitan area in the hope that they may be of some assistance to others.

Metropolitan St. Louis as delineated by the United States Census Bureau consists of 6 counties and 151 municipalities, covering an area of 3,500 square miles, located in the States of Illinois and Missouri. Of the area's 2 million people, approximately 1.5 million live in St. Louis County (including 96 municipalities) and in St. Louis City. The remaining 500,000 are scattered over 50 communities and 5 counties on the Illinois side. These figures illustrate the multiplicity of political jurisdictions within the metropolitan area.

The Interstate Air Pollution Study developed through two separate requests for aid from the U.S. Public Health Service. In 1962 the Commissioner of Air Pollution Control for the City of St. Louis asked for help in resolving an odor problem and the Chairman of the Mayor's Air Pollution Committee in East St. Louis, Illinois, requested assistance in drafting an air pollution ordinance. PHS investigation of the situation showed the problems to be interjurisdictional and of such severity that isolated control measures would be ineffectual. Interested parties met with Federal representatives and further meetings revealed enough local concern to undertake an extensive cooperative study.

In the fall of 1962, representatives from the States of Missouri and Illinois and local metropolitan agencies drafted the Interstate Air Pollution Study Project Agreement, signed in January 1963 by representatives from the St. Louis Division of Air Pollution Control, the City of East St. Louis, Illinois, St. Louis County Health Department, the Eastside Health District in Illinois, the Missouri Division of Health, the Illinois Department of Public Health, the Chamber of Commerce of Metropolitan St. Louis, the U.S. Public Health Service and the Bi-State Development Agency. The Bi-State Development Agency was established by interstate contract between Missouri and Illinois, charged with planning and development in the Missouri-Illinois Metropolitan area, and coinciding with the air pollution study area. The St. Louis Health Department and the Illinois Air Pollution Control Board later joined the study. An executive committee composed of representatives from the participating agencies was created to serve as a policy-making body.

It is important to note the wide range of agencies signing the study agreement. Cooperating agencies included local control agencies, both State and local health departments, an interstate agency already operating between the two States concerned, the Federal Government represented by the Public Health Service, local industry represented by the Chamber of Commerce. In developing any new air pollution control programs it is necessary from the very beginning to involve the various community factions. Cooperating agencies in St. Louis felt that only in this way could they develop an effective control program that would be technically and economically feasible, as well as acceptable to the community.

The first major phase of the study was the collection of detailed data on air pollutants in the area. To gather this information a network of sampling stations was installed. Local agencies contributed clerical, professional and field personnel plus laboratory services. The Technical Assistance Branch of the PHS National Center for Air Pollution Control provided a full-time technical staff, equipment and additional laboratory services. An Interstate Air Pollution Study Office was established in the City of St. Louis and the U.S. Public Health Service agreed to evaluate the data.

Local communities provided half of the $500,000 required to finance the interstate study. The Federal Government contributed the other half, plus an additional $250,000 for the meteorological research activities, making a total of $750,000 spent for the study over a three and one-half year period.

The broad objectives of the study were: (1) to assist the two States and various local agencies in strengthening and coordinating air pollution control programs; (2) to augment existing knowledge on the nature and distribution of air pollution and factors affecting its prevention or control.

The study was divided into eight major parts: (a) introduction and review of existing information; (b) emission inventory; (c) air quality measurements; (d) odor report; (e) meteorology and topography; (f) effects of air pollution; (g) opinion surveys and air quality relationships; (h) a proposal for air resource management, including a proposed ordinance.

Because a first step toward control is to find out where the pollutants are coming from, the emission inventory was an important part of the study. Through the Associated Industries of Missouri, 1,800 of the largest firms in the area were sent questionnaires to obtain information on fuel consumption, refuse disposal and industrial processes. Although only 330 questionnaires were returned, the responses accounted for more than 90 percent of the area's industrial fuel use. Most of the pollutants were found to come from the central 400 square miles of the study area where 95 percent of the people lived and worked. Industry was found to emit about one-third of the total amount of pollution in the area. Approximately another third came from transportation sources, while the remaining third resulted from refuse-burning in open dumps and residential burning.

To determine the quality of St. Louis air as presented in the section on air quality measurement, an air monitoring network of 42 sampling stations was set up. Over 70,000 pieces of aerometric and meteorological data were processed during this phase of the study, which measured dustfall, suspended particulates, carcinogens, total sulfation, sulfur dioxide, visibility, total oxidants and aeroallergens. Information from the CAMP Station (a continuous air monitoring program, one of nine PHS stations of this type throughout the country) was used in conjunction with the data collected in the interstate study measurement stations.

One of the most interesting aspects of the study was the public opinion survey made by Southern Illinois University. It was conducted through person-to-person interviews to answer questionnaires. The study found that almost half of the metropolitan population was at least somewhat bothered by air pollution, and nine out of ten people believed that air pollution affects health adversely. Eighty-five percent of those questioned said they were willing to pay one dollar a year in additional taxes to control air pollution, and 65 percent said they were willing to pay five dollars a year as a cost of living increase for the control of air pollution. A Bi-State type of control agency was generally preferred over any other form of enforcement mechanisms.

During the summer of 1963 a separate survey was conducted among public officials. Although 90 percent of the public felt that something should be done about air pollution, 72 percent of the officials said they didn't have an air pollution problem in their jurisdiction. Officials did not feel that their legislative bodies or the public would support taxes for air pollution control, but this does not agree with the public opinion survey. The people of St. Louis were apparently more willing to improve the quality of the air they breathed than their governmental reperesentatives realized. I might add, however, that things have changed greatly since 1963 and the public officials are now well aware of the need for air pollution control. This change was effected by the excellent support and the outstanding coverage given the air pollution problem by the news media and by the addition of a full-time health educator in air pollution to the St. Louis City Health Department. Through these channels, public discontent with the present situation was made known to the officials.

All information collected for the interstate study was sent to a data processing center in Cincinnati to determine the emission levels and degrees of pollution reduction necessary to obtain clean air. The final achievement of the interstate study was the drafting of a proposed air pollution control ordinance. The proposal was first developed by a subcommittee to the interstate study executives. The entire executive committee then discussed and voted on the proposed ordinance, section by section. In order to develop an ordinance that would be technically and economically feasible for the whole metropolitan area, the executive committee meetings were open to representatives from industry who could suggest alternate proposals and explain how these suggested regulations would affect them. Although this procedure delayed the completion of the proposed ordinance beyond the original deadline, the executive committee believed it was important.

From these deliberations, a comprehensive ordinance evolved. The ordinance listed long-range air quality goals as objectives to be met in obtaining clean air for the community. To meet these air quality goals, the ordinance set emission standards for the various pollution sources. In addition, the air resource management program included proposals concerning the administration of the program in the metropolitan area.

The study recommended further that the programs on the Illinois and Missouri sides be coordinated by a contract between the two States. Both States' statutes permit such an interstate contract, with approval by each State Legislature and ratification by the U.S. Congress. Since this is a time-consuming procedure, there must first be control action on the local level. The interstate nature of the problem points out the need for local or regional control programs to be backed by a strong State legislature which empowers the state to make interstate contracts.

The saying that "air pollution knows no political boundaries" is already hackneyed, but this situation crops up again and again in such large metropolitan areas as Chicago and Gary, Indiana; New York and New Jersey; Kansas City, Kansas and Kansas City, Missouri; and, of course, St. Louis. Interstate cooperation is an essential part of any metropolitan control program that crosses state boundaries.

With the completion of the interstate air pollution study recommendations, the procedure of translating these recommendations into law for adoption by the various jurisdictions of the metropolitan area was taken over by the East-West Gateway Coordinating Council. The Gateway Council consists of 12 public officials equally divided between Missouri and Illinois, with a thirteenth member from the Bi-State Development Agency. The council was originally created as a highway planning agency for the metropolitan area. On December 8, 1965, this council formally accepted the responsibility for coordinating air pollution control in the metropolitan St. Louis area.

The East-West Gateway Council held three public hearings on the interstate study recommendations. Industry representatives, government officials, and the public stated their support for or grievances against the study proposals. The Council is now studying all alternatives and modifications presented at the hearings and, after further consultation with government and industry representatives, will recommend an ordinance which, we hope, will be enacted throughout the entire metropolitan area.*

The Council was an excellent vehicle for such leadership roles, because it spanned both the Missouri and the Illinois sides of the river and included representatives from the various political jurisdictions in the metropolitan area. From the beginning of the interstate study, there was a widespread belief that a uniform ordinance would be needed throughout the entire metropolitan area. As previously mentioned, there are 151 political jurisdictions in the area; it is clear that differing ordinances would create a situation that would make enforcement and control impossible. Although the East-West Council has no enforcement powers or authority to tax, it can instigate the adoption of a uniform ordinance.

The ordinance proposed by the interstate study is still under deliberation by the Council. However, it appears that the adoption of standards based on the interstate study is inevitable. The standards will have to be adopted locally and properly enforced, or the two States will intervene. Should it prove necessary, the Department of Health, Education, and Welfare has the power to intervene.

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*A comprehensive ordinance was recommended by the Gateway Coordinating Council for the St. Louis Metropolitan area. The recommendation was somewhat less stringent than the recommendations contained in the report of the Interstate Study Committee. More recently, the Missouri Air Conservation Commission has adopted standards equivalent to the interstate study. The City of St. Louis has adopted an ordinance comparable to the Missouri State Standards and St. Louis County has introduced an ordinance with comparable standards.

During the three-and-one-half years of the study, local agencies in St. Louis County and City were enforcing the smoke and fly ash provisions in existing legislation. Both the city and the county were also working with industry on a voluntary basis. The results have been quite gratifying. Both city and county have received Federal grants for the improvement of their programs.

The St. Louis County program has grown from a staff of 3 in 1964 to 15 at present. All have received in-service training, either at the Public Health Service Center in Cincinnati or in the St. Louis area. The county has developed an air pollution laboratory and soon will be using a specially designed mobile air sampling trailer unit. The City of St. Louis has an air pollution staff of 25 and is in the process of developing laboratory facilities.

This has been our experience with the development of air pollution programs in the St. Louis area. Unlike many environmental health programs, there is no prescribed set of standards which can be adopted by communities which, if properly enforced, will assure clean air. Due to variations in pollution sources, meteorological and topographical factors, and the extent to which air quality goals are exceeded in an area, control programs must be designed to fit the needs of each community. Every community needs an evaluation of the air pollution situation before a good control program can be started. Although the gathering of information need not always be as comprehensive and time-consuming as the interstate air pollution study in St. Louis. However, our experience in setting air quality goals and emission standards, and in the procedure followed to get the program under way, may be used as guidelines for other communities.

Here are some suggestions for the development of local or regional air pollution programs born from our experience:

1. Get the help of experts. Any control program must be based on a wealth of technical information about the sources and the problems in the community.

2. After all information is collected, study the findings to develop air quality goals and emission levels to meet these goals.

3. Once new air quality goals and emission levels are proposed, plan your control approach carefully. Consult further with representatives of industry, local and State governments to be sure that the new standards are technically and economically feasible and that the administrative and enforcement procedures are the best possible for the area.

4. If the community is a large metropolitan complex, be sure that regulations are uniform throughout the area. Each agency should enforce the same laws and use the same enforcement procedures.

5. If the metropolitan area crosses State boundaries, secure interstate cooperation in drafting and passing control ordinances and implementive recommendations.

While we in the St. Louis area have not yet begun enforcement of our new ordinance, it seems obvious that new standards, once adopted, are no better than the staff which enforces them. The control staffs in St. Louis County and City will have to be expanded greatly; the State of Illinois will have to organize a regional pollution control program on the Illinois side of the Mississippi River. Funds for these air pollution control programs will have to be increased. The interstate study has recommended an expenditure of at least 50 cents per capita per year for an effective control program. The public, too, must be willing to pay for better air pollution control.

As is evident from our experience, initiation of a new local or regional air pollution control program can be accomplished at the local level. The Federal policy is not to preempt local authority, but to help in the development of a strong local or regional program. Every opportunity is given to the communities to solve their own pollution problems, with assistance from the Federal Government, if requested. It is therefore the responsibility of local and State agencies to take action to clean up their air, and to do so now. We in St. Louis hope our experiences may be of some value to others in developing a comprehensive air pollution control program.

". . . elected to Los Angeles County Board of Supervisors in 1956 with highest vote ever recorded . . . former mayor of Pasadena . . . for eight years Chairman of Los Angeles County Air Pollution Control District . . ."

IMPROVING EXISTING LOCAL OR REGIONAL AIR POLLUTION CONTROL PROGRAMS

WARREN M. DORN*
Member, Los Angeles County Board of Supervisors
Los Angeles, California

There is one crucial factor in programs to control the destruction or pollution of man's environment—every minute of every day the forces of demolition become greater and stronger.

If the experts are correct in predicting that by the year 2000 the population of the nation will be 300 million, it is obvious that any plan or program designed to solve today's problems of pollution are certain to result in failure. This is true because environmental resources—air, water, space, and land—are essentially fixed, while the opposing forces increase, some of them geometrically.

The conclusion is that constantly accelerated measures to control air pollution are absolutely necessary, not only to improve present conditions, but to insure survival of life as we know it. The blunt fact is that we can lose the battle against air pollution even if the planned programs are carried out.

A report to the Board of Supervisors of Los Angeles County from our Air Pollution Control Officer shows that Los Angeles still will have an unacceptable air quality by 1980, even if Federal and State vehicle programs go forward as scheduled. For example, there is no projected control over evaporation losses, oxides of nitrogen emissions, or pollution from used motor vehicles.

Effective air pollution control is also very costly. Our stationary-source control program has eliminated or prevented about 6,000 tons of contamination per day at an estimated cost of three-quarters of a billion dollars. That this is the down payment only is demonstrated by the fact that rubbish collection and disposal alone cost $55 million a year in Los Angeles County. Our legal battles with the fuel oil industry have resulted in a cost of a quarter million dollars and the end is not in sight.

In short, it is imperative that current control programs be maintained at the highest plane of effectiveness. At this very moment, county air-ground patrols are operating, seeking violators of our air pollution control laws. Meanwhile, we must buy time until the research is done, truly effective programs are developed, and the money is made available.

Some of the long-range improvements which I suggest will be hard to accept. Others have already proved to be effective in practice.

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*Read by C. D. Ward, General Counsel, National Association of Counties.

IMPROVE THE SCOPE OF THE AGENCY

Twenty years ago, Los Angeles County found that regulation on a city-by-city basis was impractical. Los Angeles County has within its corporate limits approximately 76 municipalities. Attempts to achieve uniform regulations in the many jurisdictions proved to be ineffectual. Our solution was the Air Pollution Control Law of 1947 which established a new administrative agency encompassing the entire county.

Later the San Francisco Bay area found that with several counties sharing the same air, a district including all of them was necessary. This was accomplished by special act of the Legislature. Truly, air pollution knows no boundaries.

The lesson is that it is possible for new governmental agencies to be formed to attack regional or interstate problems. It is not necessary, of course, that a city reduce its own effort just because a larger agency has been formed.

This suggestion should not be interpreted as recommending a large control agency. It may be that in some cases the program is being diluted by using an agency that is too distant from the problems.

SEPARATE THE PEOPLE FROM THE POLLUTION

If we have not done so already, we should face the fact that *complete* control of industrial air pollution is in the future. Events of the past few years make it clear that some sources can be moved from residential areas. Here, I am not speaking only of putting dirty industries on the other side of the tracks. Specifically, I mean that industry, primarily electric powerplants, can be converted to nuclear energy or moved to less populous areas. Hydroelectric power can now be sent long distances economically.

Southern California soon will be receiving electricity generated by coal-burning plants in Nevada and New Mexico and hydroelectric power from the Pacific Northwest. We are somewhat behind in the development of nuclear power as compared to other areas.

The important point here is that governments can encourage the relocation of these sources of air pollution. We believe that our air pollution rules (62 and 62-1) which restrict the use of fuel oil, have contributed to the decision of the power companies to remove new plants from congested areas.

ANTICIPATE TECHNOLOGICAL PROGRESS

In the late 1950's it became apparent that the development of controls for the automobile was lagging. The industry seemed impervious to criticism, pleas, and even threats. Informed persons knew of the notorious contributions of motor vehicles to air pollution. They also knew it was technically possible to control the emissions.

In 1960 on my motion, our Board of Supervisors instructed the County Counsel to prepare a strong bill which would create a State motor vehicle program. This bill (AB-17) provided for certification of devices and prohibited the sale or registration or use of motor vehicles without approved devices. It is history that the law produced the desired effect. The recent (1965) Federal legislation follows closely the California law. Automobiles now sold in California are controlled, and in model year 1968 there will be nationwide control.

The foregoing illustrates the concept that air pollution programs must lead and must follow the development of hardware controls. Indeed, most of the progress has been made with industry being faced with an existing regulation with which it must comply.

CHANGE TO CLEANER FUELS

Much too little has been done in this area. After the great industrial cities won the battle of unrestricted burning of soft coal, this field was largely neglected. Today, progress is being made in controlling the use of certain types of fuel, primarily high-sulfur coal and oil.

In 1958, our Air Pollution Control Board approved rule 62, requiring the use of natural gas during the warmer half of the year. This rule has been extended to cover the entire year as long as natural gas is available. Like most of the United States, California is an importer of natural gas, and it was apparent from the start that we had insufficient gas available to replace high-sulfur fuel oil. The Federal Power Commission controls such situations and all interstate pipelines. The search for new supplies of natural gas culminated in hearings before the Federal Power Commission.

We were aware of New York City's defeat in the Transco X-20 case, but we knew we had a better case. In the recent decision in Transwestern Pipeline Company et al., the Federal Power Commission certified an additional 593 million cubic feet per day for Southern California. This is not a year-round supply even for the near future, but it will certainly help to alleviate the problem. We intend to keep pressing in this area until pollution from fuel burning ceases to be a problem.

STOP UNNECESSARY BURNING NOW

Anyone approaching the capital city of one of our western "big sky" States must first travel through the smoke from a burning dump. Rubbish incineration is still common almost everywhere, except in Los Angeles County, where it is outlawed. If we are serious about air pollution control, then there is no rational excuse for permitting the burning of junk automobile seats or other refuse.

Efficient municipal incinerators are a partial answer, but let us not delude ourselves into believing that they are the ultimate remedy. Just as the way to stop smoking is to cease entirely, the way to stop unnecessary burning is to prohibit it.

This is not an easy thing to accomplish. Our District rules on open burning and single-chamber incinerators were adopted only after much verbal bloodletting, including picketing, referendum elections and large expenditures for cut-and-cover dump sites which we utilized, when covered, as recreational areas. Few of our citizens today would go back to that relic from the smoky past—the backyard incinerator.

MAKE USE OF FREE INFORMATION

Very few local agencies can afford to develop the scientific information they need. Of course, all of us rely upon the information provided by the Federal Government and by technical literature. It should not be overlooked, however, that colleges and universities are often able to make special studies and provide expert advice without cost or at a nominal consideration.

In Los Angeles County, we have been extremely fortunate to have the services of a carefully selected volunteer scientific committee of outstanding scientists and medical men, who meet regularly, consult with and advise the technical staff of the Air Pollution Control District, attempting to determine what constitutes adequate standards of air quality and to prescribe emergency provisions relating to air pollution control.

Through the knowledge and devotion of the committee, assurance has been given to the people that a tragedy of the type that occurred in New York, Pennsylvania and London will never occur in the Los Angeles County basin. Clearly, their services could not be duplicated for any amount of money. We also receive considerable support from the County Medical Association without cost to the County.

IMPROVE LEGAL METHODS OF CONTROL

Unless the problem of the agency is a limited one, the control officer must be equipped with all the effective legal tools available. Some of the more important provisions are as follows:

1. *Delegation of authority*. The control board or legislative body must be as close to the problem as possible. A separate agency with administrative power is effective here. At the other end of the spectrum is the program which must rely on State or Federal legislation to solve individual problems. This process is far too time-consuming and cumbersome in this age of rapid technological change. Administrative decisions such as the decision to grant or deny a permit should be under the local control officer.

2. *Criminal sanctions*. The program should provide for a criminal penalty for violation of the regulations. If the public and the industry know that the control officer will hand out a citation, then the infraction probably will not occur. If you have time

for the luxury of warnings, hearings, and injunction proceedings, then perhaps you can get along without the criminal penalty. However, in metropolitan areas, the result will be unnecessary air pollution.

3. *Variances.* The provision for variances is probably the most misunderstood area of the law. Many believe that this is the provision for special privilege. In truth, a law, whether it involves zoning or air pollution, can be much stronger if provision is made for the exceptional case. The ultimate purpose of variance provisions of course is to preserve the constitutionality of the law when its application in a particular case is unreasonable or oppressive.

In our experience, persons under temporary variances diligently worked to correct their problems. They know that the hearing board takes a dim view of dilatory tactics. Under California law, the variance will not exceed one year and most are granted for only a few weeks.

4. *Injunctive relief.* Without a special statute it is impossible in most States to enjoin violations of criminal laws unless the violation constitutes a common law nuisance. This means that State legislation must be secured to provide this remedy. The injunction is useful in cases of large or continuing emissions, but for the ordinary case is it almost valueless.

The reasons for this are that such cases take too long to complete and tend to be complicated. In some situations, the process will change or the business may change hands or cease operation before final judgment is entered.

5. *Preventive law—the permit.* It is obvious that an air pollution program which seeks primarily to prevent deleterious and injurious emissions is far more effective than a program which depends upon occasional visits by a violator to the criminal courts or protracted litigation in civil actions.

In order to prevent harmful emissions, our District has adopted a permit system under which any person who seeks to install or modify any equipment which is a potential source of air pollution must first obtain a permit from the control officer. Therefore, before the emissions are generated a method of control must be devised. Any person who installs or modifies such equipment without first obtaining a permit from the air pollution control district is guilty of a misdemeanor. It is easy for a prosecutor to win his case when the sole issue is whether the defendant did possess a valid permit. Our rules also require that the permit be posted on or near the machine, easing the job of the inspector.

6. *Power.* Any program intended to solve the serious air pollution problem must provide the control offical with all the powers known to the law. A legislative body which denies him these must carefully examine its motives, such as whether it is more interested in not offending someone than it is in cleaning the air.

ELIMINATE SPECIAL PRIVILEGE

This may prove to be a difficult subject, but it should be faced. Time and time again one hears the argument that the little fellow or the backbone industry should be exempted. Our experience has been that tough air pollution laws have not caused a ripple in the economic progress of Los Angeles County. Most industry is more attracted by clean air than is repelled by effective regulations.

In the early years the growers of our famous citrus orchards used smudge pots which cast a vile cloud over the basin and blackened white curtains in a single night. It required much persuasion and missionary work to induce the growers to abandon the protection of an agricultural exemption. Today smokeless orchard heaters do the job much more effiicently than the smudge pot.

One cannot always be successful in struggles before the legislature against the seeker of special treatment, but our experience in many such conflicts is that an air pollution control board willing to fight can prevail over strong lobbying campaigns.

CANNOT WAIT FOR POSITIVE PROOF

Most of the progress in air sanitation has been made on the basis of pioneering circumstantial evidence. This should not be surprising to anyone familiar with the development of sanitation in medicine and surgery. One hundred years ago public health officials suspected that filth and certain communicable diseases were related. Thus, long before the development of the science of bacteriology, efforts were made to alleviate disease by eliminating filth.

We are well past this era of mere suspicion in the field of air pollution. No expert of any stature will argue that air pollution controls should await more evidence that air contamination is a menace to human health. Much of the medical and scientific evidence has been developed in the recent past.

If we had waited for this confirmation, many years could have been lost. Instead, our program is based on the simple approach that all air pollution is at best a blight, and that it must go. Our rule controlling sulfur dioxide was adopted in 1948, years before the New York and London disasters, and many years before sulfur dioxide and its reaction products were identified as the cause of illness and death. This rule was bitterly fought by special interests and nearly cost us the service of an outstanding air pollution control officer. Today the rule is accepted and the sulfur recovery operation shows a profit.

The question is whether to act now or to risk a repeat of the experience of Great Britain, where decades of air pollution have left their crippling mark. I submit that the question answers itself.

CONCLUSION

None of us can claim to be all-knowing, nor can we foretell the future course of air pollution control. If we allow events to shape our course, then we shall be sweeping up the debris of history rather than making history.

We in Los Angeles County are proud to be connected with the program which the Vice President has called a "modern legend." It is our hope that other areas may benefit from our experience and avoid mistakes.

We must never delude ourselves into believing that even the best possible administration of an air pollution control program will permanently and completely solve the urban curse of contaminated air.

Until the internal combustion engine is vastly improved or abandoned, until the burning of fossil fuels is no longer necessary, our very best efforts are essential to protect life and health and to prevent catastrophe. The issue is not whether the contribution we can make is worth the pressure, the toil, the criticism and the disappointments. The real issue is whether life in our communities will be possible and worth the living. With this at stake, our course is clear.

We can never gamble with the health of the public.

QUESTIONS AND COMMENTS

JAMES V. FEUSS (*Director of Air Pollution Control, City of East Orange, New Jersey*): Is it constitutional to propose that any interstate group should have enforcement powers that are not already available in the separate States?

LOW: My approach is a feasible one, I think: it is the same type of district-wide approach that has been undertaken in Los Angeles and in the San Francisco Bay area, and seems to be on the way in the St. Louis area, which does incorporate two States. It also seems to me the road that we have to take in the New York metropolitan area.

The powers of actual enforcement, I suggest, should be left to local units. I suggest that this would be a constitutional approach because, for example, the Port Authority has powers of condemnation. In fact, some of us think that the Port Authority is not always responsive to local needs, but I suggest that a district organization could be allowed that would take into account the need for responsiveness to all the people within the jurisdiction of the district. This might be done by the incorporation on its board of directors or trustees who might be elected officials; or some other technique might be devised. I further suggest, since there has been such an erosion already of local subdivisions, that we should stand up and say that some of these local subdivisions and State lines are antiquated, out of date, make no sense; and that if we really want to protect the health of our people we have to move in a rather dramatic fashion.

FEUSS: But the law still must be adopted by the State, and enforced by the State.

LOW: The law must be adopted by the two States and possibly by the Congress, as is the case with the Port Authority.

FEUSS: So all you're changing is the enforcement?

LOW: No, sir. We have no area-wide standards now and I think this group, as a priority matter, would make area-wide standards. My second suggestion was that Federal funds would not become available to any agency within the jurisdiction of that district which did not conform with those district-wide standards. This would be leverage of the same type that is now being used by the Federal Government to obtain regional planning in the allocation of funds for highways and for mass transit.

FEUSS: Wouldn't Federal standards do the same thing?

LOW: Federal standards is another approach, but I'm not sure the people from North Dakota would be as willing to go along with it, since they may or may not have the problem.

DENNIS RUNYAN (*Legal Assistant, District of Columbia Department of Health*): What are your enforcement provisions regarding the installation of control devices on motor vehicles?

LOW: Do you have anything that goes beyond the Federal legislation which, as most of us know, will take effect for new 1968-model vehicles that will go on the market in September of '67?

JOSEPH M. POLLARD (*Washington representative and legislative consultant for Los Angeles County*): I think that what you have in mind perhaps is the State regulations on the crankcase devices for new cars. These had to be installed for cars sold in California as of the year 1963. We've had devices on the new cars sold in the State of California since the end of '61.

RUNYAN: How do you determine if there are any violators and what are your provisions for enforcing their compliance?

POLLARD: As of this year, new legislation of the past session, the State Highway Patrol is enforcing the inspection of motor vehicles—on a spot-check basis at present—made possible by the recent increase in the number of highway patrolmen.

LOW: Is this just checking what they see visually or will there be a further check when the car is brought in for its annual inspection?

SCHUENEMAN: I might add that there has been quite a controversy in California as to whether there should be an annual automobile safety inspection or not. As of this time, they do not have such a thing. There is a movement to initiate this, especially in view of the air pollution control devices.

LOW: In the State of New York we passed a law last year providing for annual inspection and presumably, when the equipment becomes available, the exhaust emissions will be a part of the checkup on the vehicle, which is really a safety checkup. This checkup will include presumably a check of the exhaust emissions. But were not quite around to that yet. This is something that will come up in the next legislative session, beginning in January.

SCHUENEMAN: The State of California Motor Vehicle Pollution Control Board examines data provided by the motor vehicle companies on performance of their vehicles with respect to exhaust emission of hydrocarbons and carbon monoxide over a 50,000 mile durability test. Before any new car can be sold in California, the Board has to approve the emission control system. The Board also develops its own data, so that they know the devices being installed are satisfactory and meet their requirements. They also have roadside checks. As I understand it, these are simple visual checks to find out whether the equipment which was originally installed is still in place. Work is being done on development of a testing device that will measure exhaust emissions in a short time, say a minute or so.

RUNYAN: What kind of device does New York propose to test with—the Ringelmann chart?

LOW: I'm not familiar with the engineering device, but I know that the Chief Engineer of the New York City Department of Air Pollution Control is here and he may be able to fill you in. Or Mr. Rihm.

SID MARLOW (*New York City Department of Air Pollution Control*): New York will use essentially the same approach that the California folks would use. The Ringelmann is not for hydrocarbon or carbon monoxide emissions. This is for visible emissions from motor vehicles in general and you do police that by using a Ringelmann chart. You must watch the vehicle go by and assess the smoke.

JOHN GUYER (*City Councilman, Houston, Texas*): Does your local Chamber of Commerce work with you on the prevention of air pollution? Have your ordinances been enforced?

LOCHER: The Chamber of Commerce did testify before our City Council committee (in Cleveland) and we did have pretty much of a consensus before the legislation was passed. It has been tested and there is certainly no constitutional question about our legislation.

C. D. WARD (*National Association of Counties, Washington, D.C.*): With respect to Los Angeles County, the Chamber of Commerce was very cooperative and the newspapers are especially so. I think they perhaps led the battle for the air pollution control agency. The legal department of Los Angeles County is headed by Harold W. Kennedy, who is perhaps one of the outstanding legal experts in air pollution control law today, and the department has been spectacularly successful in its ordinances, including Rule 62, which relates to the control of fuel oil.

REINHART W. KOCH (*Montgomery County Health Department, Rockville, Maryland*): How do you establish political responsibility for air pollution controls in regional agencies? It is a problem. How do you make the regional agency responsive to the people, so it doesn't take off on its own and start to run over everybody?

MITCHELL: The plan in the St. Louis metropolitan area is set up so that the local agencies, if they are qualified to run a program, will continue to operate their own program, for example, in the City of St. Louis, which has a very extensive program at the present time, and in St. Louis County. On the other hand, there is no agency on the East Side in the 54 counties over there; and that's a 500,000-population area. At the present time, the thought is that this is actually going to be handled by the State health department which operates the air pollution program. Because they have a bunch of small towns over there, most of them too small to operate their own programs. Then another layer may have to be added, since a contract between the States of Illinois and Missouri is anticipated, as provided for in the statutes of both States, and, which of course would have to be ratified by the U.S. Congress. They would establish uniform standards, hopefully based on the studies that we have done for the area, because these are the best data available. Then, if any of the agencies that are enforcing it on a local basis stump their toes and fall flat on their faces, the Interstate Contract would intervene, and its standards would then be enforced. But only when the local authorities refuse to do it, or refuse to do it adequately.

WARD: With respect to the political responsibility, I refer you to the San Francisco Bay area situation, where this was an extremely important consideration. There were five or six counties involved.

LOW: I think we have a developing body of experience here and certainly it is well worth reporting and publicizing. I hope Mr. Thomas Williams will take note of this and see if we can get the Public Health Service to put all this in a pamphlet so that we can profit by the experience of all of the areas that have been trying to deal with the district or regional approach.

R. THEODORE SMITH (*Professor, Jamestown Community College, New York*): The point has been made that if local control of air pollution is to be in fact effective, adequately trained personnel must be available. The point has also been made by the Vice President and others that a three-way partnership must exist among the Federal, State, and local agencies. I wonder if any of you gentlemen on the panel would care to react to this question: Do you feel that the Federal Government is currently doing enough to support training of personnel to serve in air pollution abatement programs. If not, what could they do that they are not presently doing?

LOW: Mr. Schueneman said that about 15 to 20 percent of the air pollution control jobs are vacant.

MITCHELL: I feel that we have been very fortunate in the training that we have received with our staff from the training branch of the Public Health Service. We now have 15 people on the staff and all of these people in the last two-and-a-half years have had from three to five courses in the Cincinnati training center. In addition, the Public Health Service brought a team in to the local university and held courses in our area to train other field personnel in the city, the county, and the eastside Illinois suburbs. We feel that the PHS training has been very effective, mainly because we have received so much of it.

LOW: I might say that I don't speak for the administration in the City of New York, since I'm in the legislative body, but the new law enacted in May by the City Council provides for a process of certification which I think is somewhat similar to the permit approach that Mr. Ward mentioned. So, in order to operate a piece of heating equipment or an incinerator in the future, you are going to have to have a certificate. This is going to require a fairly large staff of engineers and chemists. I understand that we're having great difficulty in hiring competent personnel to get on with enforcement of this law. The new law outlaws incinerators entirely in new buildings after two years. I think we have to observe that the Federal Government, on the other side of the coin, has not helped us because it has been stealing some of our people. (Incidentally, I think all control people ought to be better paid.) But, if the Federal Government keeps upping the ante, it's going to be more difficult for the local agencies to go ahead with their own programs.

SCHUENEMAN: I would like to point out that the present Commissioner of Air Pollution Control in New York City was "stolen" from the Technical Assistance Branch, Division of Air Pollution, Public Health Service.

LOCHER: On that subject I understand that the National League of Cities at its recent national meeting resolved that, while it is the primary responsibility of local governments to find their own personnel and train them, Congress should nevertheless enact legislation which would: (a) permit State and local employees to participate in the in-service training programs offered to Federal employees; and (b) authorize a Federal grant program for the improvement or establishment of State and local in-service training programs where such Federal assistance is not now available; and (c) authorize the U.S. Civil Service Commission to join on a shared-cost basis with the States and/or local governments in the recruitment and examination of prospective employees. The representatives from the Public Health Service's Center in Cincinnati were there also and they urged further that the Federal Government assist in training and recruitment, perhaps in conjunction with the colleges and universities, to make sure we do have an adequate supply of technically trained employees. I suggested that in my paper as well. It must be a partnership. Perhaps the State Universities could provide the training, with the States subsidizing them; that way, we could obtain the thousands of trained men and women we need.

LOW: We'll take due note of this comment when we make our report. There is agreement on this if not on some of our other subjects.

EDWARD J. PUGH (*Health Officer, City of Wilkes-Barre, Pennsylvania*): We have two main problems in air pollution in Wilkes-Barre. One is burning culm banks with millions of tons of burning culm and a fairly high sulfur dioxide emission—in some regions air concentrations are anywhere from .1 part per million to about 7 parts per million.

Culm is a residue from mining coal. It is called slag when it comes from an iron furnace, culm when it's from a coal mine. It burns for years. Some piles have been burning for from 50 to 100 years. The largest culm bank we have is expected to burn for at least 50 years longer; so now they're starting to remove it. The State has done some monitoring there and finds that the sulfur dioxide is up to about 7 parts per million in some places, which is quite high. They soak the culm as it's being removed, but they expect it to take about 10 years to remove; so that means we're going to have sulfur dioxide for at least 10 years from our largest culm bank.

The question is just how far we should go. The State did monitor it about two years ago; they haven't done anything since. The question is whether it's worthwhile to continue monitoring.

SCHUENEMAN: As I understand it, the State of Pennsylvania has a regulation requiring that culm-bank fires be treated by the best known methods, to minimize or, we hope, to extinguish the fires. I don't know how vigorous the State's enforcement of that regulation is, but I know it's on the books. There are close to a million dollars in Federal grants to the State of Pennsylvania, largely for the demonstration of new techniques for extinguishing these fires. Those projects are working now and perhaps the one in Wilkes-Barre is one of these projects. The State Department of Mines and Mineral Industries is also trying to find some way to put out the fires in these piles, which have been put there over a period of 50 to 100 years of coal mining. The fires are awfully difficult to put out.

PUGH: We have a second problem. Practically every miner who has worked in the mines for over five years has anthrasilicosis. Until the last few years, the mine owners objected very strenuously to our x-raying them. During the last two years, we've examined them at the Kirby Health Center in Wilkes-Barre with State funds and also with local funds and some Federal funds. We are undertaking projects to find out just what the situation is and what can be done for these miners. In the last year we have examined perhaps a thousand or more of them and we continue to do that. The question is whether we can really do something to take care of the air pollution in the mines which is causing anthrasilicosis.

RAYMOND M. MANGANELLI (*Professor, Rutgers University, New Brunswick, New Jersey*): You have mentioned something like the New York Port Authority as a desirable kind of organization, please comment on one that is already existing, the Interstate Sanitation Commission, its powers and activity in air pollution. Can its powers be expanded to include your proposals?

LOW: I mentioned that at the outset in my prepared remarks. This agency does exist, but I said that it was impoverished and maybe ought to come in under the antipoverty program. Further, it doesn't have the authority to do anything really except funnel complaints to an agency if an agency exists. So this is not critical of that handful of people who work for the agency; when an agency has not been given sufficient tools to do the job and it's been in existence for a long time, it seems better sometimes to start all over again. If the Interstate Sanitation Commission charters could be strengthened by support from the legislative bodies of the two States, and then this compact be ratified by Congress, there would be nothing wrong with that.

MANGANELLI: What I wanted to know (just for my own edification)—here is an existing body that has already been approved by the States and ratified by the Congress, why can't . . .

LOW: You would have to go through the legislative bodies again and through the Congress again to authorize this body to deal with air pollution. It is functioning now in the water pollution area and maybe it can go ahead with that function. But we also need an air pollution district that will have different powers, as I have suggested with respect, for example, to the allocation of Federal funds. Every burning process that we undertake is a source of pollution. So you have an entirely different means that must be adopted to deal with the problems.

MANGANELLI: The separation of water pollution and air pollution is rather artificial. We'd like at least to preach to our students the concept of the total environment and tie in together all the separate aspects. Mr. Schueneman indicated that the majority of local air pollution programs are in existing health departments. Mr. Clodfelter also mentioned that, if you put air pollution programs under existing health departments, you give them the kiss of death. I'd like Mr. Schueneman to comment from his experience rather than from a local angle. Where do you think such programs—for communities of about 100,000 people—should be housed to be most effective?

SCHUENEMAN: For communities of the size range you mentioned (about 100,000), I doubt that the organizational structure would be such that you would be able to justify a separate department for pollution control. You would have to put this function in some existing city agency in order to share laboratory facilities, and perhaps to make use of inspection staff. Most often this will be the health department.

I would have to agree with Mr. Clodfelter (as you quote him) that there are some air pollution agencies in health departments that are dead. But there are a lot of them in other agencies that are also dead. There are some independent agencies that are not too lively. It all depends on the administrator of the program, the backing he gets from the public and from political officials in the community.

CLODFELTER: Quoting from my paper—"By locating a new program within an established agency, you have given this program the 'kiss of death' as to its regional growth. The majority of the city-county health, building, and safety departments do not include a multicounty area."

LOW: I might observe that in the City of New York today, at the City Council meeting, the Mayor is presenting a reorganization program to create 10 administrations, one of which Professor Manganelli would be particularly interested in, an agency or administration dealing with environmental problems. Within the agency will be the Department of Air Pollution Control as well as the Department of Sanitation. So, structurally speaking, this looks good for an approach.

But the City's program in air pollution control is one thing, whereas the water pollution control program is a $750-million capital-budget program which involves money to be expended by the City essentially to control waste disposal into the surrounding waters. The programs are actually quite dissimilar although there certainly would be nothing wrong with a single head to deal with environmental programs.

GENARO G. CONSTANTINO (*Chief, Division of Air Pollution, Providence, Rhode Island*): The permit system—and here I am in complete agreement with Mr. Dorn, as quoted by Mr. Ward—is most essential if new potential sources of air pollution are to be prevented. We've had a permit system in Providence since 1957. I'm certain that, as a result, a great number of new sources have been prevented by requiring that adequate means of control be specified and applied before a permit is issued. We are fully aware that abatement or elimination of existing sources takes a great deal of time and money and in some instances we must accept corrections on a long-term basis. This is a condition we sometimes have to live with as control officials; however, there is no reason or excuse for permitting new sources of air pollution to come into being.

LOW: I would like to emphasize this because there has been some interest in what's going on in the City of New York. Our new law deals with two prime sources of air pollution, incineration and fuel burning. We try to make this a preventive program and not rely on a system of visual inspection or even of monitoring emissions, because we don't think that we're going to be technologically able to deal with it on that basis for years to come.

So what do we do? We eliminate soft coal for heating purposes entirely. We require Con Ed, the giant utility which burns 6 to 7 million tons of coal a year, to install electrostatic precipitators of 99-percent efficiency and have them completed within a period of three years. We provide for the upgrading and modernization of some 17,000 apartment-house incinerators within a 2-year schedule, and we provide for the upgrading of tens of thousands of pieces of heating equipment in the same period of time. The upgrading is required wherever residual oil is burned. We require not downgrading, but step-by-step reduction of the solid-sulfur content of soft coal or residual fuel oil that is to be burned in the City of New York over a period of five years, reaching a 1-percent level in a five-year period. And essentially, we also provide for the certification of equipment.

This is a new approach. I think it's in line with the idea of prevention. We leave the door open if somebody says he can take the SO_2 out of the stack to meet emission standards and, if he can monitor his stacks on a minute-to-minute basis, we say OK; we don't care if you use soft coal then with a 10-percent sulfur content, if there is such a thing, as long as the emission standards are met.

These are some of the things that we provide in New York and they do go into the area of prevention. What I've said points up the need, too, for training personnel to enforce such statutes.

RICHARD I. DARNELL, M.D. (*Chairman, Air Pollution Committee, Pennsylvania Thoracic Society*): Does the State or county medical society contribute by more than "endorsement in principle" to air pollution control in any area known to the panel? Of 12,000 M.D.'s belonging to the Pennsylvania Medical Society, probably no more than 100 are at all familiar with the program of the Commonwealth. If such cooperation has been obtained, what was the most effective approach to obtain it?

LOCHER: Our Air Pollution Control Commissioner and our Director of Health and Welfare have been working with the medical authorities in the City of Cleveland and they have received the cooperation and support of the medical association. There is also a very active person, or several of them, including one who is constantly on radio and TV urging that we do more in Greater Cleveland in this regard. So the medical association has been extremely active and we have worked with the association. I think that is one way to receive very good support from the public at large, because it helps them to realize that the medical practitioners and those who are experts in this field are working with them.

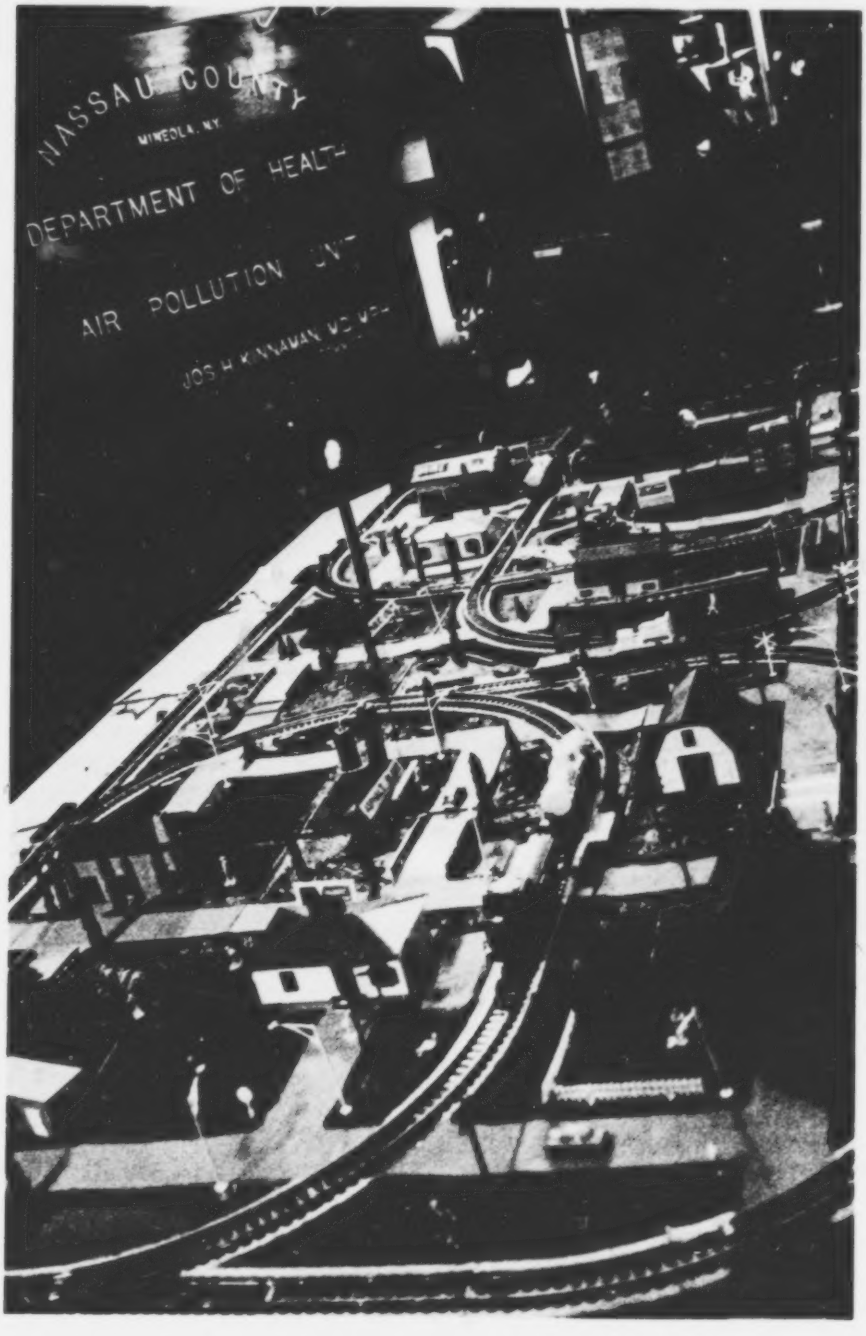
SCHUENEMAN: In general we have been disappointed by the support lent to the air pollution effort by official bodies of the American Medical Association, both nationally and locally. Evidence of this on the national level is the fact that two people in AMA's headquarters who were concerned with air pollution, have recently left their jobs. We find isolated instances where the County Medical Associations support air pollution control efforts, but by and large, I would say that the support from AMA and its county societies has left much to be desired.

LOW: The AMA had a conference (I believe in Los Angeles) last year on air pollution. I understand that the California Society is very active.

In New York City when we came across this problem—and it is usually the first thing we do come across, of course, the health impact—we have relied very much on the studies of Dr. Greenberg, who is a former Commissioner of the Department of Health, Air Pollution Control. He is both an engineer and a physician, and he is now in preventive medicine at the Albert Einstein School of Medicine. We have also profited by the work of Dr. McCarroll who was at Cornell Medical School and I believe now is in the State of Washington. The information we got from both doctors was, by and large, statistical in nature; it points out correlations, which help to demonstrate that dirty air is bad for you. To make the point clear, they have taken episode after episode and shown that when you have an inversion, a stagnant air mass, your SO_2 readings go up precipitously. Keep in mind that the actual mortality rates that are kept by the Department of Health go up in amazing correlation. The death rate goes up, not only among the elderly and those already suffering from lung ailments or respiratory diseases, but also apparently among the population at large. So I for one have never tried to expand upon the medical evidence in a causal relationship, but have pointed to the statistical information.

WARD: From the elected official's standpoint, I think it's essential that the medical profession be very much involved. It makes it much easier for the politician to come out with rules and regulations when he has the physician saying that the rules and regulations are desirable. In San Francisco, there is an advisory board which advises the county supervisors and the mayors with respect to rules and regulations. I believe it is required by their procedure that at least three physicians be on this advisory board out of the total membership of twelve. We recommend that, if at all possible, physicians be involved.

LOCHER: In our Air Pollution Control Bureau we have what many of you also have, an industrial hygiene or environmental health division. This is, we feel, a necessary part of our air pollution control agency. That is one way in which we have already brought in the physicians, because we're concerned about the health of the workers and the plant environment along the lines that were suggested for the coal mines, which we don't have in Cleveland, although we do have many basic industries there. That's one way to bring in the health people. Then, we go a step further and employ them in the way Mr. Ward mentioned, to lend credence to what we are saying. In that way, you can do more toward getting support of the citizen at large, I believe, than you can in any other way.


NASSAU COUNTY
MINEOLA, N.Y.
DEPARTMENT OF HEALTH
AIR POLLUTION UNIT
JOS. H. KINNAMAN, M.D., M.P.H.

". . . retired after 20 years of Navy service . . . President of Nevada Association of Public Health Sanitation . . . Vice President of Nevada Public Health Association . . ."

CONCLUDING REMARKS

HOWARD CLODFELTER
Air Pollution Control Officer, City-County Health Department Reno, Nevada

In concluding this session, I would like to bring out a few high points of some of our papers this morning.

We now have about 135 city, county and multiple-jurisdiction air pollution control agencies in the United States, each spending at least $5,000 per year. The budgets for these agencies range from 1.8 cents per capita to 83.3 cents per capita per year. To operate an adequate comprehensive program, it is recommended that at least 40 cents per capita is needed. With only some 15 programs meeting this standard, it is evident that greater funding and effort are needed.

Local communities are, in increasing numbers, recognizing the regional nature of air pollution problems. From 1961 to 1965 the number of individual city programs decreased, while the number of countywide programs increased from 15 in 1961 to 36 in 1965. The number of multicounty programs increased from two to six, while city-county programs grew from one to eleven and multicity programs went from three to six.

It was also noted that the majority of these programs are established with existing health departments. However locating a new program within an established agency, such as the health department, building department or safety department, impedes the developments of a regional concept since few health department or building departments cover a multicounty area.

The papers presented this morning provide excellent guidelines, which we may follow for establishing or developing local or regional air pollution programs: (1) recognize the problem; (2) finance a program; (3) collect data to define existing air quality; (4) prepare and adopt uniform regulations for the entire metropolitan area; (5) develop a training program for key personnel in the enforcement staff.

Air pollution control is not just a problem for large metropolitan areas; it is a problem for every community. Planning should start today, even though a program may be several years away. For example, in Washoe County, Nevada, which has a population of 125,000, the annual average growth rate since 1960 is 9 percent. Air pollution problems have developed with the expansion of the area's industrial base. In October 1963, a regional program was established. In May 1964, uniform ordinances were adopted by the City of Reno, Sparks and Washoe County.

The uniform ordinances were adopted in spite of pressure groups within eight months after the regional program was established. The city councilmen and county commissioners who voted for the measure were reelected.

Because of our air pollution control program, we now have compulsory trash and garbage service for the two cities. This made regulation of burning and incineration easier to enforce.

We now have the advantage of cooperative effort. Our industrial growth has been planned by the Chamber of Commerce, industrial development staff, and a regional planning commission. We promote the expansion and establishment of light, nonpolluting, manufacturing and processing industries, warehousing and distributional facilities.

By the year 2000, the population of the nation will be 300 million and any plan or program designed to solve only today's problem of air pollution is certain to result in failure. This does not mean that we should not plan for today, but we must also plan for the year 2000. New control agencies must be formed throughout this nation to attack the regional or interstate problems of today and the future. It is not necessary that a city reduce its own efforts just because a large area agency has been formed. Personnel in established programs must be willing to lead and assist other agencies in developing good sound programs for the control of tomorrow's air pollution.

Levee
Pearce
Heller

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AND

F

December 13, 1966

PANELS E AND F

STATE AND LOCAL AIR POLLUTION CONTROL PROGRAMS

Chairman Mrs. Michael Levee, Jr.
Vice Chairman, California
Motor Vehicle Pollution
Control Board
Beverly Hills, California

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". . . has served with no compensation on California's Motor Vehicle Pollution Control Board since its inception . . . organized S.O.S. (Stamp Out Smog), representing over 400 women's organizations . . ."

INTRODUCTORY STATEMENT

Mrs. MICHAEL LEVEE, Jr.
Vice Chairman, California
Motor Vehicle Pollution
Control Board
Beverly Hills, California

I entered the air pollution fight ten years ago as the mother of an asthmatic child, after the doctor recommended that she leave the Los Angeles area because of air pollution. I informed the doctor that it was impossible for the family to leave Los Angeles, but I naively said that I would cure air pollution.

I then started an organization called *STAMP OUT SMOG* (S.O.S.). In time, S.O.S. solicited the support of 426 other organizations and represented them before local, State, and Federal authorities in matters of air pollution.

The air pollution fight has come a long way since then, and we of S.O.S. feel we have played a major part. However, the real fight is just beginning and the difficult part is ahead. My years on the Motor Vehicle Pollution Control Board have brought into focus many of the difficulties we must overcome. Whether any of us will see this problem solved in our lifetime will depend on conquering the environmental, financial, and political complexities that face us now. The problem of air pollution is complex and its complexity must be measured and understood.

An important reality, in my opinion, which must be understood by authorities charged with the protection of the health and well-being of the citizens, is that no voluntary system will work, with either people or industry. Many people will not understand or want to pay for control programs; industry's motivating force is profit, and air pollution control costs money. Therefore, it is the duty of the government to protect industry and the people from themselves. We have the scientific know-how to significantly solve the air pollution problem. The major obstacles standing in our way are lack of money, and politics.

In a large metropolitan city such as Los Angeles, the fragmented pattern of government within the metropolitan region is a fact of urban life. It is not likely to change. Any significant redistribution of political power on a regional basis—the "metro-government" objective—remains outside the bounds of probability, not to mention feasibility. Effective regional government is simply not about to come soon in metropolitan areas.

The financial fact is that the major metropolitan cities are bankrupt. New York's annual deficit is almost half a billion dollars; Boston is even worse off (relative to its size). In Los Angeles, recent desperate decisions with respect to new excise taxes clearly demonstrate the financial position. It is clear that the primary revenue base of local government has been exhausted. This, then, is the city of the future . . . the very near future . . . bankrupt financially and paralyzed politically.

Meanwhile, in Los Angeles, the public humor centers on jokes about smog, and there is a comfortable consensus that everything is going to be all right if we can just find a way to build a mass rapid-transit system. Everything is not going to be all

CONTROL NOW-
FOR CLEAN AIR!

right. The conclusions I have stated are based on facts—observable, demonstrable facts. These facts make up a hard reality that will not yield to rapid-transit systems, or community action programs, or property tax reform. In short, it will not yield to what is largely a "safety valve" system of cure with measures designed to take effect over the span of a generation. The issue, if it is still open, may be resolved long before then by a London-type disaster.

The ability of our society to respond to the great challenge—whether today, this country can come to grips with the air pollution crisis of its cities—is a momentous question for those who place their faith in the democratic society. The basic requirements for effective action are clear; there are just two momentous answers: (1) There must be a commitment on the national level sufficient in strength to establish priority over many other domestic goals; (2) the priority commitment at the national level must be definitive enough to penetrate all layers of the Federal-State-local decision-making apparatus.

Air pollution knows no city, county, or State boundaries, and its control will never be effective without the Federal Government setting the standards for air quality and supervising their enforcement throughout the Nation.

After ten years of involvement in air pollution, I hope I do not sound cynical—but I wish us all lots of stamina and lots of luck.

". . . air pollution engineer, formerly with U.S. Public Health Service . . . researcher and planner with major industrial companies . . . holder of patents for industrial waste processes . . ."

FEDERAL, STATE, REGIONAL, AND LOCAL RELATIONSHIPS IN AIR POLLUTION

AUSTIN HELLER
Commissioner of Air Pollution Control New York City

During this conference we have said quite often that air pollution is a highly complex subject. It is. Relationships among the levels of government can superimpose on it an additional knotty tangle of administrative complexities. I'll try to say something coherent about this sticky subject. I'll be talking about five things: (1) who among Federal, regional, State and local people is doing what; (2) how one local control program—New York City's—works; (3) how it is helped by outside resources; (4) what can be proposed as improvements; (5) what happens when the chips are down, as during the Thanksgiving air pollution episode.

WHO DOES WHAT?

At its inception, the Federal Government was given powers to perform only those functions which the States could not implement themselves. The States were expected to provide the major police and welfare services for their citizens. For, as the tenth amendment reads, "The power not delegated to the United States by the Constitution nor prohibited by it to the State, is reserved to the States, respectively, or to the people."

One of the powers retained by the States is the police power for the preservation and protection of health, safety and general welfare of its citizens. In general, the States through appropriate legislation, delegate this power to the municipalities. However, this does not preclude the right of Congress to enact legislation that affects the general welfare of States. The Federal Government has been capable of adapting to radical changes in technology and environment without abandoning the historical philosophy of decentralization. The American system of government is a flexible one which adjusts to the needs of the nation while maintaining the broad principles which guide its action.

The rapidly evolving patterns of our national air pollution problem suggest that the role of the Federal, State and local governments be reexamined. This is a timely moment to do so. Congress to date has consistently declared that the prevention and control of air pollution is the primary responsibility of State and local governments. The principal role of the Federal Government continues to consist of research, technical support and encouragement of State and local programs. However, the Federal Government may enter the field of abatement in cases of interstate pollution. Legislation supporting research, education and stimulation in the emerging area of air pollution control has been pivotal in developing the capability of the nation to respond effectively.

Similarly, the states have, in part, supported and cooperated with municipal and regional agencies to meet these problems and have assumed responsibility for effective programs in nonurban areas. For example, New York State has taken the leadership in stimulating local programs with a schedule of reimbursement in the amount of 50 percent of municipal expenditures for air pollution control. The Interstate Sanitation Commission has been designated to study the regional aspects of the air pollution problem and to recommend appropriate control legislation. The Metropolitan Regional Council is concerned with the broader aspects of organization.

But although the Federal, State and regional structure is essential, air pollution remains mainly a metropolitan problem stemming from advancing technology and increasing urbanization. The concentration of energy sources and industrial processes in a relatively small geographic area poses a special air pollution problem not generally found outside the metropolitan areas.

In New York City, as in other metropolitan areas, such a complex challenges the community which has now developed a reaction to meet this challenge. Until recently, the thrust of our air pollution control program was based almost entirely on correcting existing situations. Attention was focused on control of smoke and particulates from combustion sources and the control of nuisance and other discrete emissions into the atmosphere that were capable of technical and economic control. We operated without defining what was meant by desirable ambient air quality and we tended to overlook its significance as a starting point in air resource management programs.

In developing such a program, decisions must be reached on a carefully planned procedure that includes: (1) defining the problem; (2) setting realistic goals; (3) examining relevant data; (4) choosing among alternatives; and (5) goal-directed action.

Some of the major elements of air pollution in New York City are particulates, sulfur oxide, carbon monoxide, aldehydes and odors. The major causes of air pollution are fuel combustion, incineration, power generation, automobile exhaust and industrial emission. The city problem is further complicated by the staggering volume of pollution emanating from the multiplicity of varied sources concentrated in the whole metropolitan area surrounding the city.

Goals have been set for the city calling for a substantial roll-back of contamination to be achieved within five years. Ambient air quality objectives also have been agreed upon. We are expanding the air monitoring network to 36 sulfur dioxide and suspended particulate sampling stations throughout the city. Ten of these will telemeter data on sulfur dioxide, carbon monoxide, coefficient of haze and meteorological systems. A continuing emission inventory of pollutants caused by industrial processes, transportation, space heating, power generation, and incineration, and how they are affected by atmospheric conditions, will provide a primary base for the control program.

We are developing a cooperative research program with the New York City Health Research Council, Columbia University, New York University and Cooper Union. We hope for the energetic application of the physical sciences, engineering, medical and biological disciplines in developing a solution to our air pollution problems. The scientific resources available to the urban center are set to work on a solution to its problems. The fruits of these efforts would have universal application. We plan to initiate a broad economic study to measure the impact of air pollution on our environment and to assess the cost of controlling emissions to meet our air quality objectives. We will undertake a massive public awareness campaign to mobilize the citizens and the resources of the community. This can only be achieved by bridging the gap between the scientific community and the public through a strong educational campaign.

The battle for cleaner air cannot be fought only on the local front. A successful control program for New York City implies a regional control program. Therefore, its development is an integral part of the job. Control of air pollution will be built into the urban planning activities for New York City.

A computerized system for all aspects of our program will aid in continuous scientific evaluation. By using the techniques of systems analysis we will be able to obtain and record adequate information on the emissions inventory, the aerometric network, and the enforcement program.

The municipal government has provided the statutory authority and the direction of the city's program. It has contributed the basic financial support on which the effort is structured. Both the executive and legislative branches responding to the impact of the problem and the public demand, have provided a legal framework for an aggressive and dynamic air pollution control program.

In the face of serious financial limitations, the city has reversed a general economy drive to authorize and facilitate a sharp expansion of the air pollution control program, both in the area of general enforcement and upgrading of the city's own facilities. The city has actively solicited support and technical assistance from the private sector. The business community has responded by providing high level technical personnel which would otherwise be unavailable to the city's effort and has organized to provide further support for its programs.

The New York City program could never have come into being if it were the city's alone. However, it is really the product of the cooperative efforts of all extensions of government. The city's legal capability comes from the devolution of state powers which enable the city to deal effectively with the problem. The state has also provided stimulation and support for the city's program by the financial support earlier cited. The city's technical and financial capability has been in part derived from Federal support.

And here is the nub of the subject: relationships among the levels of government. The enlightened and continuing relationship with all levels of government has stimulated city control activity, both in terms of the assistance provided and in anticipation of continuing support in the development of a dynamic and imaginative control program.

An efficient attack on the urban air pollution problem requires the leadership of each level of government in the area in which it is most effective, each working to get the job done. I would like to make some specific suggestions on coordination of the resources of the three levels of government.

REGIONAL RESEARCH CENTERS

Research centers supported by appropriate government agencies and the private sector should be erected in those urban areas where the problem of air pollution is especially manifest today and where it is expected to pose an even greater threat in the near future. Research is required to develop answers to specific urban or regional air pollution problems and to develop further insight into the problem as a whole.

Such centers would reinforce the control programs of a region by providing a medium for the exchange of ideas and professional personnel. They should be linked with the academic resources of the region, both to stimulate the development of skilled and professional manpower services for the control program, and to provide a base for adequate manning of the research center. They would also tend to attract professionals of high competence and thereby contribute towards a more rapid and efficient solution to the air pollution problem.

GRANTS

Air pollution is an urban problem. Here it assumes its most complex form; here it affects the greatest concentration of population; and here it poses its greatest threat to the health and welfare of its residents. Here also, especially in the core cities, are found the most viable organizational capabilities for an effective attack on the problem. A cogent national program should demand that adequate resources be made available to core cities with the capability of translating these resources into abatement action.

An evolving and experimental program demands the maximum of flexibility to meet the urban problem effectively. Inflexibilities in administering the present grant program (such as the 12½ percent limitation on the distribution of Federal grants as provided in Section 104 c of the Federal Clean Air Act governing development, establishment, improvement and maintenance grants) pose a block in the most direct and effective use of available Federal funds. In crisis urban areas, this limit should be extended.

OPTIMAL USE OF PERSONNEL

The urban air pollution control program continues to demand the development of new skills of a high professional level which are currently scarce and which are urgently needed. This demands a maximum of flexibility to apply available manpower to the more important areas at any given time. Such a disposition of manpower would also require a total assessment of manpower requirements to establish priorities pertinent to the overall effort. An effort of this kind would encompass a Federal manpower pool for technical assistance as needed, and efforts should be made to promote programs which would lend flexibility and mobility to the extant professional manpower of the nation. A corollary of this approach would involve the evolution of training programs to fill the manpower need for the total air pollution program. Some of these aspects are now underway.

FEDERAL STUDY COMMISSION

There is an urgent need for the redirection, reassessment and integration of the air pollution program now scattered among many agencies on all levels of government. Policy needs to be established for the decade ahead. A study commission should be constituted to examine the organization of the total control effort and to evolve a mechanism capable of efficiently coping with the problems ahead. An important area for study by such a commission would be the development of a regional response to air pollution.

At one end of the spectrum would be the voluntary structure of cooperating communities. At the other end would be the integrated organization of regional control, incorporating all powers incidental to such an effort. In viewing these structures, consideration should be given to the resources available to regional effort and the strengthening of those elements which would contribute meaningfully to the integrated program. Such a study would also encompass the suggestions already set forth as basic elements of such a comprehensive program.

NEW YORK SMOG ALERT

In New York City the air pollution menace is a clear and present danger to the community. The threat became very apparent on Thanksgiving of this year when a 4-day inversion threatened to become a catastrophe. The situation is a case history of governmental relationships and how they work in the time of emergency.

The U.S. Weather Bureau issued, at noon on Wednesday, November 23, 1966, a high air pollution-potential warning forecast for the next 36 hours. As a result, the department laboratory was ordered on 24-hour-a-day operation. We secured voluntary agreements from two major utilities, Consolidated Edison and Long Island Lighting, to change the fuel use patterns from coal and oil to natural gas, in an effort to reduce sulfur dioxide and particulate emissions. On the basis of laboratory reports of the contaminant levels, we advocated the institution of an air pollution watch. This was in turn recommended by the Interstate Sanitation Commission to the New York and New Jersey State control agencies. When air quality worsened during the night, the City Sanitation Commissioner agreed to shut down municipal incinerators until further notice.

On Thursday, Thanksgiving Day, all inspection personnel were called to duty. The Interstate Sanitation Commission and State Health Department were in frequent consultation with us. Medical advisers within the city were called for help and advice. On Friday morning, after further forecasts were received from the weather bureau, and when the laboratory reports worsened, the department conferred with the Mayor, the State Health Department, Interstate Sanitation Commission and state agencies in New Jersey and Connecticut. Agreement was reached to call a first stage air pollution alert at noon; simultaneous announcements were made by the city and the three states.

About 60 percent of the private apartment house incinerators were shut down, voluntarily. The City Housing Authority reduced heating in its buildings and eliminated incineration. On Saturday, November 26, it was possible to rescind the alert, but the watch was maintained until Monday morning.

The wind and the rain came, the blanket of pollution lifted, the public breathed easier, and some tired public servants got a little sleep.

In view of the rather loose arrangements some questions remain:

In an emergency, should there not be a plan of action that goes into effect automatically?

Can we rely on voluntary conformance with requests for measures that reduce pollution?

Why does our system depend so much on voluntary and individual initiative?

What would have happened if willing and knowledgeable people had been unavailable to give the orders?

What if the utilities had not had a supply of gas available?

What should the Federal role be?

Can Federal hospitals be mobilized to perform the mortality and morbidity studies so necessary to develop medical knowledge of air pollution and respiratory disease?

Can Federal facilities and personnel be employed in an emergency to help local agencies?

The urban air pollution problem is fast approaching crisis proportions and according to recent newspaper headlines, the crisis has already arrived in New York City. Densely populated metropolitan centers are attracting additional multitudes into limited areas. Technological changes threaten to further complicate the air pollution problem with a potential for death, disease and destruction which may be realistically projected in the absence of a forthright control program.

The time to act is *now*. The action must be adequate to meet the problem in a way that befits a most advanced nation sensitive to its duty to serve the welfare of its people. The role of the Federal, State, regional and local governmental entities requires examination of their present responsibilities to meet the current and future air pollution problem of the urban areas of our nation.

". . . teacher . . . president of Miami Women's Club, later the district, the State, and the national organization . . . participant in eight international conferences . . . Regent of State university system . . ."

VOLUNTEER ORGANIZATION ACTIVITIES AND AIR POLLUTION CONTROL

Mrs. E. D. PEARCE
President,
General Federation
of Women's Clubs
Miami, Florida

When I consider the American situation where we are so urgently concerned with the tests and rewards of self-government, I'm reminded of the cataclysms of waves off a point at Cape Hatteras. Many of you have stood there and watched the Gulf Stream and the countercurrent come rushing at one another. When flayed by the wind, the wave pattern created by the engagement of these currents is a constant pounding, rolling, lapping and overlapping, chaotic and churning structure. Hatteras, as you know, is justly famous or infamous as the wrecker of ships, yet most of the years go by without such deadly incidents. Usually, the waters toss and the unceasing energy of the ocean carries out its work. The waters which rush head-on are accommodated and blended together.

In the same way, it seems to me, there occurs the ceaseless and seemingly incoherent jostling, adjusting and mixing of many interests—governmental and private—which form the exciting design of our national life. The various and multiple rushing streams, or to change the metaphor, the groups of people speaking with many tones, or the profuse and several colored strands which form the fabric of our life, are not to be deplored as incoherent or unmanageable. Rather, I believe, one must understand and respect the important contribution of each section, whether private or public, in this American pattern. And one should rejoice at the opportunity to watch and to experience—to be a part of—this national design. In so doing we will give proper homage to the fact that all areas are needed—and give honor to the work of the voluntary organizations in self-government in helping to make things in our country go in the direction we know they should move!

Especially do voluntary groups need to believe in the worth of their contribution. As a member of a voluntary citizens organization speaking on the subject of volunteer citizens groups, I believe my single most important comment today is "we voluntary groups need a spirit of self-confidence and cooperation." The interested citizens groups' theme song should be, "I Believe in You."

Yes, in order to do the very best job possible, citizens groups do need a spirit of self-esteem and belief in their own work. They must be overwhelmingly aware of the importance of their donations of time, money and talents to public affairs. Groups such as ours are needed to represent the average citizen in these days of big, complex government when the person may feel himself several light years away from ever touching the levers of government. Secondly, citizens groups must believe in the value of their undertaking in these technical areas such as air pollution. We must not retreat helplessly when confronted with the knowledge explosion or the occasional technical expert who uses his information as a weapon of personal power.

Just read some of the technical publications available here at this conference. What's a normal, democracy-loving citizen to do? As decisions of government grow increasingly complex, are we to give up democracy and take up technocracy, because we just can't take part in self-government?

So we need self-confidence—and I hope I can convince you today—or remind you—that voluntary groups are here to stay. Further, rather than involving ourselves in an either-or struggle, I hope we can convince the professionals in the many areas of public endeavor that the key to solution of our grave national problems is cooperation. Although we need confidence to walk into this highly complicated and technical subject of air pollution, we are not going to become experts.

I'm not here today to talk with you about the complexities of how our air is polluted. We have engineers and chemists who can supply this information in some detail. The technical experts, however, need us and we, the civic experts, need them. Science and industry and lots of people have brought about this problem of air pollution, and together we must solve it. The spirit of cooperation is the quality that will help us work successfully with government, business and other voluntary groups. It's a spirit or attitude we in the GFWC look for in judging our General Federation of Women's Clubs—Sears-Roebuck Foundation Community Improvement Program. More than 11,000 of our 14,000 clubs entered this community-betterment contest during 1964–1966. In that program, competing clubs must show, among other things, how they worked with other community groups in solving their local problems.

The subject of air pollution is one where we members of volunteer groups need these two qualities of confidence and cooperation, for air pollution has a meaning in the lives of each one of us; it really *is* a citizens' problem. I cannot think of a problem which affects more of us so intensely. No man or woman can elect to become a hermit, withdraw and shut out this problem, because he can't shut out the air or stop breathing. We few Americans—sparse in numbers in comparison to the world population—are so fortunate in our island of privilege, with our bountiful, balanced diets, with our electric toothbrushes, with our color television sets. Yet we are so underprivileged, disadvantaged if you will, that we breathe dirty air.

No beautiful home seems to be exempt from the corroding filthy air; beautiful clothing is ruined; fortunes in livestock and vegetation are sacrificed. Eleven billion dollars is the oft-quoted figure we use as the annual cost of air pollution, but what of human health, happiness and well-being? No one can put a valid price on these important intangibles. Clearly, dirty air surrounds us, infringes on our well-being and health. What could be more of a people's problem? As responsible citizens we would want to help combat this menace, but, in addition, each of us is personally harmed by the "garbage in the air."

What do we, the voluntary groups, the civic experts, have to offer to help solve this problem? Where can we start? What can we do?

First, we must remember that volunteer organizations are a mighty force for education. I don't know if anyone has called us the fifth estate or not, but that could indeed be our informal title. For we take up where the fourth estate, the press, leaves off. One of our major functions is to interpret in depth the important issues of our day. Many of us have carried forward anti-air pollution programs for some time now. The General Federation of Women's Clubs' first resolution on air pollution control is dated 1955. However, solution of the air pollution problem must wait on public education and indignation before vigorous combative action will take place.

There is much to do. As Surgeon General William H. Stewart recently pointed out, "most cities and States are still without the services of effective control programs." He noted that only 33 States had air pollution programs, and many were scarcely more than nominal. "Only 58 percent of the urban population of the United States is served by local air pollution programs."

Education through public conferences has been an effective tool of women's clubs in recent years. In Denver, where cars and the smog from backyard incinerators bedim the light—the former crystalline view of the Rockies—the Women's Club won first place in our General Federation of Women's Clubs contest, the Clean Air Community Action Program. This is a program which we sponsor with the Public Health Service.

The State Clean Environment Chairman for the Colorado Federation of Women's Clubs was one of the leaders in organizing the first Colorado Air and Water Pollution Conference in November 1965. At the conference attended by 750 people, many registrants were State legislators, and 10 percent were federated clubwomen.

One followup was a Women's Conference on Air Pollution held in Denver, where representatives of many groups exchanged information on current legislative proposals and on activities which their clubs were already carrying forward against polluted air.

We all know that rural areas, as well as urban, have air pollution problems. A small club in a small town recently won an award in our clean air community action program. Club members in a Delaware area presented a program of simple steps, nothing elaborate, which had considerable influence on local and national action to help combat the air menace there. In my home State of Florida a magnificent job was done in the anti-air pollution program, in connection with the phosphate mining in Pope County.

Every action that these women took was well thought out. It was consistent with, and focused on, the goal and it was effective. Their program to combat air pollution combined education and action.

For example in Selbyville, Del., the town became known as "Smellyville" when the processing plant across the State line really got going. The chief nuisance here was a truly nauseating odor. A government inspector could not finish his inspection because of this overwhelming problem. The fact that the offending plant was in another State's jurisdiction complicated the problem.

The Woman's Club members aroused public interest in taking action against the smell by the following steps: They held group discussions open to the public. They used a calling system, reporting the time and day, wind direction, and length of time they were forced to endure the odor. They displayed materials on health and clean air in city hall. A clubwoman appeared on local television. They attended and testified before a Clean Air Conference in November 1965.

In Rochelle Park, New Jersey, there was no subtle modern chemical mixture ruining the air. It was something people could touch and taste and sometimes crunch, for there were clouds of cement dust blanketing the town. Instigated by the Woman's Club, the township called in the New Jersey Health Department which found the plant to be a health hazard.

I am going to pass on to you some suggestions on what voluntary organizations can do. We have adopted and adapted the following suggestions for taking effective action in the community:

1. Get the facts. Organize a study group to gather information on economic, social and health effects of air pollution in the community.

2. Distribute newspaper and magazine stories describing air pollution incidents, the economic effects of pollution, reports of plant damage and similar items of interest.

3. Feature a clean air program as an annual project. Dramatically present to your audience the air pollution facts that you have collected.

4. Conduct sight-seeing tours to polluted areas in your community.

5. Form an air pollution photography project to take pictures of plant damage for display to club groups or for use in exhibits.

6. Organize a study project to examine State and local legislation dealing with air pollution.

7. Keep current on all new local, State and Federal legislation. This is most important. Inform your elected and appointed officials of your concern with air pollution. Offer your support.

8. Request time from your local radio and television station to present to the public the facts of dirty air.

9. Sponsor a school assembly program or an essay poster contest. Acquaint the younger generation with the problems they are inheriting. Interest school officials in presenting classroom material concerned with man's fouling of his environment by polluting the air.

10. Organize a speakers bureau to provide other groups and organizations with lectures on the need for clean air.

11. Prepare displays and exhibits.

12. Support bond issues or referenda which are designed to strengthen air pollution control efforts.

13. Conduct a community survey to learn what others think of the air pollution problem and what suggestions they have to offer to assist you in your clean air campaign.

14. Introduce resolutions calling for action to clear the air.

15. Enlist the support of other groups and organizations in your community.

16. Form an awards project with prizes or certificates for the most notable contribution by an individual or club working for clean air.

17. Talk with your local newspaper editors. Interest them in featuring clean air material. Provide them with facts and figures.

18. Participate in National Cleaner Air Week held every October. Write to Cleaner Air Week, 2400 Reading Road, Cincinnati, Ohio.

19. Appoint a representative to attend and participate in community and State meetings concerned with air pollution.

20. Extend your activity beyond local club.

The important thing is to begin now, to come to grips with the growing threat of air contamination. It is my hope that you are convinced that citizens groups can, should and must work even harder to disseminate information and encourage action at every governmental level to fight air pollution. I know that many of you here have interesting stories to tell about your organization's activities, and I welcome the opportunity to share some ideas with you.

". . . physician . . . past president of National Health Council . . . clinical professor of preventive medicine, University of Rochester . . . chairman of air conservation for National Tuberculosis Association . . ."

DISCUSSION

EFFECTIVE INVOLVEMENT OF THE GENERAL PUBLIC IN THE CONTROL OF AIR POLLUTION

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The need for a far greater involvement of the general public if there is to be an effective attack on air pollution, has been emphasized repeatedly as specific efforts to improve the quality of air have been attempted. This theme has been stressed by many thoughtful and knowledgeable observers. Dixon and Lodge,[1] in discussing the report of the American Association for the Advancement of Science Air Conservation Committee, comment: "The best program in the world can fail in the face of opposition or apathy on the part of the public. The commission report calls upon the public to undertake three tasks: (1) To become familiar with information about air conservation and air pollution, calling upon the scientific community and the Government for assistance; (2) to consider the problems of all segments of the community: industries, utilities, and private citizens; (3) to urge, permit, and require the appropriate governments (Federal, State, and local) to take actions necessary to ensure that the air of the areas within their respective jurisdictions is of the quality desired by the people of those areas and that the quality is maintained."

Recently Dr. Haagen-Smit,[2] a distinguished contributor to the understanding of the pollution problem in Los Angeles, in a discussion of the factors involved in improving conditions in that area, stressed that public apathy is the greatest air pollution problem. Goldner [3] makes a similar observation concerning conditions in Boston: "Insofar as public-policy formulation is concerned, the dominant theme is widespread public apathy. Apparently there are substantial groups of people throughout the area who are very severely affected by localized air pollution problems and who vent their extreme unhappiness on the local authorities or occasionally on the State Department of Public Health. However, in the nature of the situation, their complaints would be more effective if they were brought to bear on the legislature and if their efforts were organized and sustained. Presumably, in the operative system of decision-making, these people comprise one of the disadvantaged, inarticulate groups which lack both the resources with which to bargain and access to the people who do bargain. In contrast, the groups which tend to oppose effective control action, because their economic interests are at stake, are highly organized and articulate."

PUBLIC INVOLVEMENT

In the past few years there has developed a greatly increased effort to control air pollution. With the major stimulus of the Federal Clean Air Act in 1963, many segments of our society accelerated their attention and action to the problem. Governmental agencies, first at the Federal, and later at State and community levels, began to receive more realistic support, and to develop more effective programs. Scientific and technological societies, with emphasis on environmental evaluation and control mechanisms, have increased their activities substantially. The health professions have broadened their studies and interpretations on the health aspects of air pollution. Industry, on an individual level and through its associations, has expanded its effort to control industrial effluents. Conservationist organizations have amplified their programs of public information on the harmful effects of air pollutants on wildlife and plants. The summed effect of these efforts gives a hopeful, although admittedly premature, promise of reversing the statement in the National Academy of Sciences-National Research Council report, *Waste Management and Control*,[4] that "the problem is growing faster than are present-day solutions, both qualitatively and quantitatively."

All of these organizations—governmental, industrial, scientific, professional, and conservationist—have involved public information components in their programs. Community service organizations such as the General Federation of Women's Clubs and the Junior Chamber of Commerce are making important contributions in the attack on air pollution by focusing on this problem. In some communities, particularly where the problem is severe, citizens have organized special groups such as "Citizens for Clean Air" or "Action for Clean Air," but the difficulties in involving a broad citizen interest and commitment, and the lack of a substantial interlinking or national base, has limited the effectiveness of such sporadic associations.

For a number of years, some of the affiliate associations of the National Tuberculosis Association have been concerned with the rapid increase in morbidity and mortality due to emphysema and chronic bronchitis. They have conducted programs to measure the prevalence of these diseases in the community, to assess the increased incidence, and to establish and improve clinical facilities for the care of the growing number of people with pulmonary disease and disability. The aggravating effect of air pollution was noted, and the possible causative relationship studied. As the cumulative impact of these programs increased, the Board of Directors of NTA recognized the need for a national, well organized, and sustained effort "to increase the public's understanding of air pollution and motivate the public to act soon." [5] At the February 1966 meeting, the Board committed tuberculosis associations to a nationwide air pollution control effort, with the establishment of a national commission, composed of knowledgeable and influential citizens, including representatives from NTA, the American Thoracic Society, and the National Conference of Tuberculosis Workers.

The goal of the new commission, the National Air Conservation Commission, is to guide and assist citizens' efforts to restore clean air. It will cooperate with other organizations sharing this goal. The NTA, with 1,834 affiliated State and local associations, offers a broad base for effective national action.

The National Air Conservation Commission will publicize facts:

NACC will make more widely known the nature, causes, and complexities of the air pollution problem.

It will identify the costs of pollution to the individual in ill health, in dollars spent, in vegetation destroyed, in natural beauty lost—and the costs of control to the community, to industry and to government.

It will speak to the public interest at conferences, forums, and legislative hearings.

It will report on the findings of research, the realities of energy demands and health and esthetic needs, and the types of regulations necessary to achieve clean air.

NACC will recommend policy:

It will support standards for clean air.

It will suggest essential features for State and community air pollution control legislation.

It will examine the connection of air pollution with other aspects of metropolitan living and point out the need for air conservation planning in such areas as zoning, industrial development, transportation, and water supply.

It will encourage necessary research.

It will indicate how communities can make use of the Federal Clean Air Act in developing or establishing control agencies, in improving their programs, and in securing technical aid.

NACC will stimulate action:

It will generate a climate of acceptance for regionwide control of air pollution.

It will stress the need for a personal sense of involvement and responsibility and a willingness to pay for clean air.

It will stimulate the public to insist on the passage and enforcement of essential regulations.

It will support the establishment of community air pollution control programs.

It will urge concerted public action to solve the problem of air pollution.

It will enlist public-spirited citizens and organizations in the cause of air conservation.

This challenge—and opportunity—was expressed so well by Dr. Dixon:[6] "One of the important social institutions of a democracy is the voluntary association—a group of persons who come together for a common cause and who by coming together concentrate local, regional, and national social and political power in ways which will effectively catalyze social action. Because tuberculosis and health associations have through belief, tradition, and experience acquired skills in community organization, they are knowledgeable about the process of social change. They have a central interest in the problem of respiratory diseases, and it is upon the respiratory tract that air pollution seems to make its most profound direct health impact in humans. These associations are used to playing the catalytic role—which is to say that they have a demonstrated ability to cause social change without necessarily expending their resources on direct services.

"The National Tuberculosis Association and its affiliates have long been active in the development of public policy. Such action has been astonishingly successful in freeing men from the burdens of tuberculosis and other respiratory diseases. One would hope that these same associations will assist in the development of public policy for air conservation."

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". . . long-time researcher in cloud physics . . . former senior meteorologist with Air Pollution Foundation . . . past president of American Meteorological Society . . ."

WHAT FACTORS DETERMINE THE OPTIMUM SIZE AREA FOR AN AIR POLLUTION CONTROL PROGRAM?

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The motions of the atmosphere and therefore, the movement of pollutants which are put into the air have no regard for political or jurisdictional boundaries. This fact, which at one time was known only to meteorologists who are the students of atmospheric motions, is now conspicuous to everyone who has flown in an airplane or driven in an automobile across city, county, and State boundaries. Whereas in earlier years we had to use meteorological data to demonstrate that the smog-laden air from the San Francisco Bay area is carried into the interior valleys of California and that the pollution from the Los Angeles area goes over the mountains and through the passes into the desert regions, today the pollution is so concentrated and extensive that its movement is readily seen directly, and the visual evidence is both more vivid and more convincing. It shows clearly that the inland counties of California cannot control the pollution levels they experience. The similar movements of pollution from New Jersey to New York and vice versa are also clearly evident (especially last Thanksgiving weekend), showing that these States cannot individually solve their pollution problems. Everywhere in the United States, and in fact everywhere in the world, where pollution enters the atmosphere, it is carried with the wind from city to city and State to State. The pollution from one political subdivision may thus affect many others.

This fact is lent statistical validity by the results of a 1961 questionnaire which was circulated by the Philadelphia Department of Public Health to all local control agencies in the United States.[1] Of the respondents, more than half reported that pollution from sources outside their jurisdiction affected the pollution level in their areas. Under these circumstances what are the factors which determine the desirable size for the area covered by an air pollution control program?

In addressing myself to this question, I am aware that in addition to meteorological factors, there are political, legal, and jurisdictional ones, and also economic and social factors related to the distribution of industrial and commercial activities and population. Inevitably, all these factors are interrelated, and although I shall be principally concerned with the physical and meteorological factors, I shall at least point out questions concerning the political and economic factors in the hope that answers will come from people present at this conference.

The meteorological factors are concerned with the processes which tend to transport, disperse, and dilute pollutants after they have entered the atmosphere, to transform them physically and chemically, and ultimately to remove them from the air. With respect to these factors we have a very good idea of those which determine the rate at which pollutants are transported, dispersed, and diluted. We have some information about how and how fast they are transformed, but we have almost no knowledge of how and at what rate they are removed. We know, however, that large fractions of the pollutants remain in the air for periods of days or even weeks during which they can be transported across State and national boundaries, and even across the oceans.

Because of the persistence of pollutants after they have been introduced into the air, it is clear that no local political boundary, say a city or county line, forms a natural jurisdictional limit for air pollution control regulation or enforcement. What, then, are the considerations which determine the optimum areas for pollution control from the meteorological standpoint?

Frequently reference is made to airsheds or drainage basins, in analogy to the corresponding concepts in the flow of water. There are indeed times when the air does flow downslope like a river, and there are places where at certain times the air is confined in a basin in the same way as water is in a lake. To the extent that the periods and places of high pollution input coincide with these places and these times, it is quite reasonable to use these natural drainage areas as a basis for control programs. However, even in the case of an area which has such natural drainage characteristics, variations of weather influences produce a variety of flow patterns, so that frequently the air pollution is carried in a different manner from that suggested by the topographic considerations, and pollution from the area concerned will move in high concentrations to other places, and pollution from locations outside the drainage basin will be carried into it. Air drainage basins thus cannot be defined as an adequate basis for delineation of pollution control programs.

Another basis for setting the limits of an air pollution control program lies in the rate at which pollution from a given source is diluted as it moves away from it. Figure 1 shows the variation of concentration at the ground of a pollutant emitted continuously at a steady rate from a smokestack into a steady wind. The peak concentration at the ground is some distance in the lee of the stack, since the pollution requires time to diffuse downward from the stack top to the ground. Farther downwind from that point the concentration drops off and eventually,

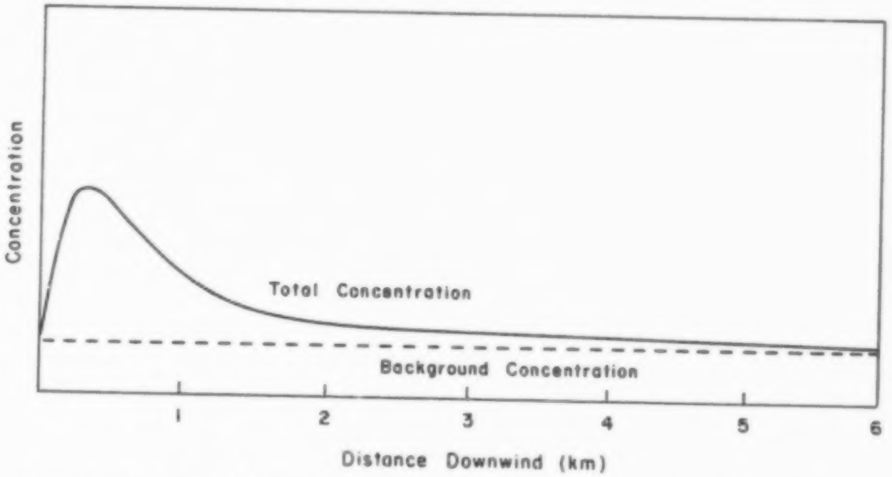

FIGURE 1.—Variation with distance of total concentration at surface downwind from an elevated source (schematic).

at a large enough distance from the stack it reaches a value only slightly above the initial background concentration. Thus in the case of an isolated stack, the area of concern from the standpoint of control is limited to the region within a moderate distance downwind of the stack. The actual value of the concentration and the rate of decrease with distance downwind depends on a variety of factors, but principally on the atmospheric stability, which depends in turn on the variation of temperature in the vertical, and on the strength of the wind, which on the one hand gives the speed with which the pollution is carried away, and on the other hand controls the amount of turbulence and thus the rate at which the pollution mixes with the outside air.

When the wind is light and there is an inversion (a layer of air in which the temperature increases with height instead of the usual decrease) the concentrations will be higher than in strong winds with normal lapse of temperature. If the pollution were confined to a single source, the boundary of the control area could be defined in terms of the distance to which objectionable concentrations might reach under adverse meteorological conditions.

In reality it is rare that one must confine the pollution control measures to a single individual source. Instead the pollution in a metropolitan area comes from many sources of many types. Emissions are superimposed, so that for the wind in any particular direction the pollution from one source is added to the pre-existing concentrations from all others upwind of it. Figure 2 illustrates this process. Instead of the pollution decreasing with distance downwind, the concentration fluctuates with a generally upward trend, reaching peaks immediately downwind of each major source, but rising again because of the next source before it falls to near its previous background level.

A similar result is obtained if the pollution sources are assumed to be distributed uniformly over the metropolitan area. In Figure 3, copied from a diagram in a paper by Hilst (1962), the rising part of the curve represents the increasing concentration due to an area source of constant intensity of pollution emission. The falling part of the curve shows the effect of dilution downwind of the source.

For a metropolitan area, whether represented by multiple sources or smoothed area sources, theory shows that the concentration continually increases in the downwind direction, with the peak concentration reached at the downwind end of the source-containing area. Beyond this the concentration falls off, but more slowly than in the case of a point source. The peak concentration may reach very high levels under conditions of high emission rates, large source

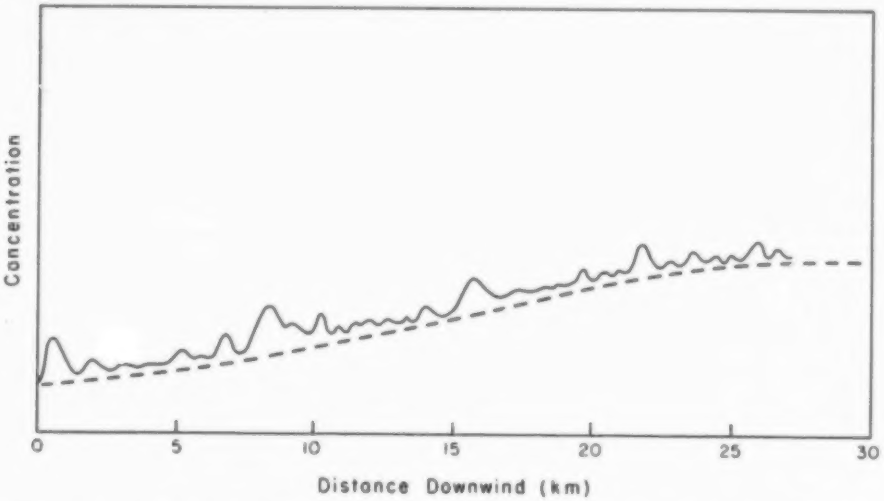

FIGURE 2.—Variation with distance of surface concentration from randomly sized and spaced elevated sources.

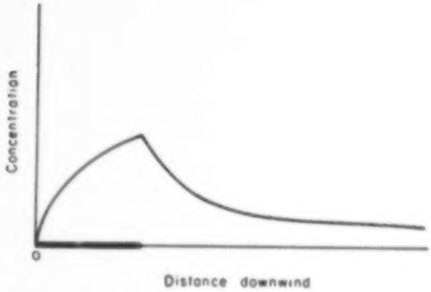

FIGURE 3.—Variation with downwind distance of concentration due to an air source of finite length.

regions and adverse meteorological conditions. The rate of decrease under adverse meteorological conditions may be so slow that places at distances several times the diameter of the source region—the metropolitan area—may experience objectionable concentrations of pollution.

The control program for a metropolitan area thus properly should include a region much larger than the metropolis if all the persons who are affected are to be considered. The specific dimensions would vary from instance to instance, but as a rough guide I would suggest a diameter for the control program region three times the largest dimension of the fully developed metropolitan area.

If the air reaches another metropolis before the pollution concentration accumulated over one metropolitan area falls to its original background level, an accumulative effect will occur. The pollution from the second metropolis adds to higher initial value, and on continued passage over metropolitan areas the background concentration of pollution in the air will build up in a fashion similar to the case of multiple point sources, but on a larger geographical scale.

To illustrate this effect schematically there is presented in Figure 4 a view of what the concentration of pollutants might be as the air flows across the United States from Los Angeles to New York. As the air comes in from the Pacific Ocean, the heavy emissions and poor diffusion over Los Angeles lead to a very high peak in concentration. After the air leaves the Southern California metropolitan area, the improved diffusion and the removal process cause the concentration to fall and by the time it has crossed the desert and Rocky Mountains it has decreased almost to the original background value. The Denver area, the Kansas City area, St. Louis, all cause individual peaks, with the farm areas allowing decreases, but once the air starts crossing the close-

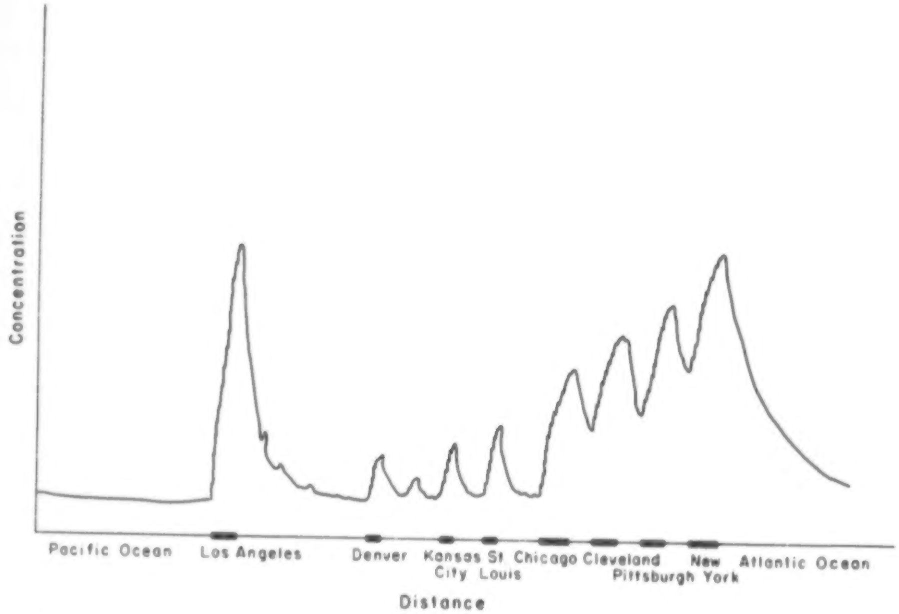

FIGURE 4.—Schematic representation of pollution concentration in air crossing the United States.

together metropolitan areas east of the Mississippi the effects of each area add to the residual effects of the ones upwind. The highest peak is that at the East Coast. The concentration after that falls off as the air proceeds over the source-free Atlantic Ocean. Presumably by the time the air reaches Europe, the concentration will have fallen to the same low background level as the air coming to the United States from the Pacific. By the time the air has crossed the Pacific again, the pollution added while it passed over Europe and Asia will have been removed, and we start the same cycle again.

From these considerations we see that when metropolitan areas are close together their pollution levels are not independent of each other. If area A has very high standards of pollution emission control, it still may be subjected to an objectionable concentration of pollution if area B upwind of it does not have adequate controls. Since the winds are variable, there will be occasions when B is affected by A as well as when A is affected by B. It is to the interest of both metropolises that they mutually coordinate pollution control to protect themselves and each other. This coordination may involve joint action by separate control agencies by means of agreements or compacts, or joining together in a unified control agency. The jurisdictional bodies concerned may include cities, counties or States. In some instances the State or the national Government could serve as the control agency.

We have the impression that at the present time the general picture presented in Figure 4 is correct: the pollutions from neighboring source areas affect each other, but at large distances the dilution and removal processes bring the levels down to the original background. In particular, we think that each batch of air entering the country from the Pacific Ocean is as clean as the previous one, but we can visualize that if the rate of emission of pollution continues to increase, we will reach the stage in which the dilution and removal processes do not completely bring concentration back to the same value after a circuit of the earth. Then the situation on succeeding passages of the air across the United States would be as shown schematically in Figure 5. At each later circuit the concentration starts from a higher background value and reaches higher peaks. In the course of time, even the concentration over the oceans will be higher than the

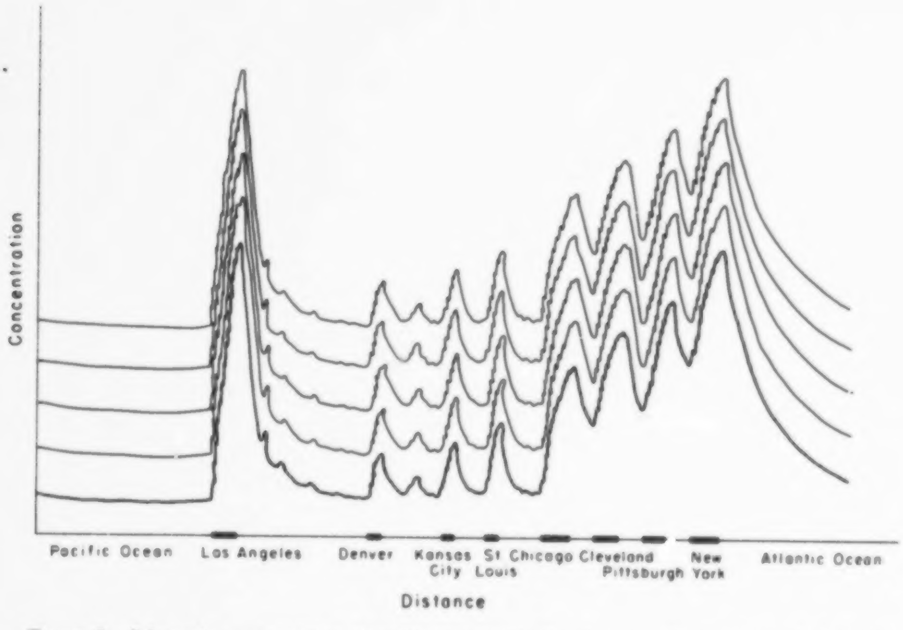

Figure 5.—Schematic representation of pollution concentration in successive traverses of air over the United States.

highest values presently attained, and the values reached in metropolitan areas will be indeed unbearable. Eventually, under these circumstances, the concentration would exceed the levels of toxicity tolerable by humans. If pollutants were poured into the atmosphere at such a rate all mankind throughout the world would indeed perish.

We do not really know whether the worldwide average concentration of such toxic pollutants as sulfur dioxide, nitrogen dioxide, and carbon monoxide has been rising through the years, since suitable measurements for the past are not available. In the case of one pollutant, carbon dioxide, however, there is definite evidence that the concentration for the atmosphere as a whole has risen about 10 percent of its value, from approximately 0.029 percent in 1900 to over 0.032 percent at present.

There are no direct toxic effects to humans from an increase of carbon dioxide as long as it does not greatly reduce the available oxygen, and even a tenfold increase in CO_2 would still leave plenty of oxygen for animal respiration. It is likely that an increase in carbon dioxide would actually be beneficial to agriculture, since it constitutes one of the limiting factors in plant metabolism.

A possible indirect adverse effect has received much attention, namely, the influence of the increase of carbon dioxide on the balance of heat and temperature of the atmosphere. Carbon dioxide is one of the principal substances in air which absorb and emit infrared radiation. As such it is largely responsible for the "greenhouse" effect, which leads to a higher temperature at the earth's surface than would exist if the earth had no atmosphere. The increase in carbon dioxide which has taken place must have altered the greenhouse effect, producing an increase of average temperature of the earth's surface. This increase has been estimated on the basis of the radiation theory to be about two or three degrees, but other theoreticians have calculated that it is only one-tenth of that amount. Since continuation of this temperature rise with continued increase in CO_2 concentration may result in the melting of the ice caps over Antarctica and Greenland and cause a rise of sea level and flooding of populated coastal areas, it is important to evaluate this effect, and perhaps to limit or eliminate the use of fossil fuels to prevent an excesesive increase of carbon dioxide.

However, I am citing this example here, not because of its intrinsic interest, but because it demonstrates that a pollutant may accumulate if the processes of natural removal do not go on as fast as the rate at which it is put into the atmosphere. Carbon dioxide is removed from the atmosphere in several ways, including being taken up by plants during photosynthesis and being dissolved in the oceans. Since these very active processes are not sufficient to eliminate it from the atmosphere as fast as the burning of fossil fuels produces it, it is possible that other more toxic pollutants may also be already accumulating in the air faster than they are being removed.

Whether or not we are already exceeding the limit of the air's capacity to cleanse itself, we certainly will do so in the future unless prompt and effective steps are taken to prevent it. As the requirements for energy increase throughout the world, the consumption of fossil fuels and the injection of pollution resulting from them will continue to rise.

Already, with only a small fraction of the world's population using energy at the rate which supports the standard of living characteristic of western civilization, air pollution is a major problem. The rest of the world is attempting to raise its standard of living and may be expected to achieve great advances in the next several decades. At least initially, these advances will surely involve the use of energy prdouced from fossil fuels, and with it the multiplication of pollution output many times, to which must be added the increases due to the explosive increase in population. The hundreds of millions of Asians and Africans may be expected, in the next century, to attain the same degree of comfort, convenience and mobility as the Western world. With smoke streaming from stacks in Bombay, Bangkok and Brazzaville as it now does in Birmingham, and with Fords and Fiats crowding the streets of Shanghai, Delhi and Lagos as well as Rome and Los Angeles, the exhaust may envelop the entire earth in choking fumes which are emitted at a rate larger than the capacity of the natural cleansing processes to remove them.

To insure that this rate of emissions on a worldwide scale is not reached, prompt national and international action is essential. Studies of the rate at which pollution removal occurs and the atmosphere cleanses itself must be carried out in order to determine allowable rates of emission of various pollutants for the area as a whole. International agreements must be arrived at to provide that these rates are not exceeded and methods of policing these agreements must be set up. Even before complete knowledge of the allowable rates is available, it is necessary that we take the first steps towards international control.

I want to remind you that Figures 4 and 5 are strictly schematic. The wind never follows a path directly across the country from Los Angeles to New York, but instead twists and turns so that the air crossing one metropolitan area may be moving southward or northward and miss all the others. Furthermore, conditions of light winds and inversions do not occur continuously in a parcel of air as it moves across the country. In one place there may be these bad conditions, but in others the conditions may favor strong mixing of air through the entire troposphere.

Nevertheless, the main points derived from a consideration of these figures are valid. The pollution levels at any one place are determined not by the local sources alone, but by the contributions of sources at large distances, and in the future they may be significantly affected by all sources throughout the world.

Under these circumstances it is clear that what is required is not delineation of an optimum size area for air pollution control programs. What is required is a coordinated program in which local, regional, State and interstate, Federal and international agencies all cooperate in the effort to maintain a healthful clean atmosphere for everyone on earth.

It is also clear that this coordinated program should be of a more fundamental and general nature than has been applied heretofore to the air pollution problem. Up to now, and for many years, we have been treating the problem piecemeal, in terms of particular localities, single sources, or specific pollutants, and the problem has continued to become more severe and widespread. Instead of this piecemeal attack, the concept of pollution control must be incorporated into the basic fabric of our economic and social life. All urban and rural planning, all industrial and domestic development, indeed all national planning and development, must incorporate consideration of air pollution aspects.

The first and foremost principle must be that all industrial, domestic and vehicular operations should be carried out with essentially no emissions into the atmosphere. With respect to industry, we have seen in Los Angeles that this goal can be approached if stringent efforts are exerted. The refinery operations there are an outstanding example of what is possible. The domestic incinerator was eliminated there, not without resistance, in accord with this principle. These steps can be taken everywhere if adequate motivation is applied.

For control of emission from vehicles, the situation is different because the technology has not yet been developed. However, it is my contention that if the Federal, State and city governments were to adopt laws setting a date, say January 1, 1980, after which no vehicle injecting any hydrocarbons, carbon monoxide, or oxides of nitrogen into the atmosphere may be operated on the highways, roads or streets under their jurisdictions, industry would meet the challenge and develop the technology to meet this requirement.

In the meantime, planning for city and State development should take into consideration the several ways pollution is affected. For instance, housing and industrial complexes should be designed to minimize traffic congestion, with large factories and apartment buildings located only where mass transit stops or feeders are available. Freeways should be oriented crosswind rather than along wind. If they have to go in a direction along the wind, then they should be wave-shaped so the pollution from them is spread. Park areas with vegetation and trees should be provided at frequent intervals throughout urban developments to provide for diffusion and removal of pollutants, and trees should be planted throughout the residential and commercial areas to help the removal process.

What is needed, then, is a coordinated program of control at all levels; city, county, regional, State, interstate, national and international. The national and international agencies must set up programs to prevent the general background of pollution concentration from rising above an acceptable level and to administer those situations where locally high concentrations cross State and national boundaries. State agencies should be concerned with overall standards applicable to their entire jurisdictions and with administration of regulations affecting more than one county or region. The regional and local agencies should establish and enforce regulations to keep local concentrations of pollution below acceptable levels. The emission standards set by each agency would be, of course, consistent with those of the larger jurisdictions, in the sense that the local agencies could set more stringent requirements, i.e., lower allowable emission rates, than those established for the entire State or Nation.

This raises the point of so-called "preemption." It is very important to have this point clarified. There has been the question raised, for instance, whether or not the Federal regulations covering the standards for pollution control equipment on motor vehicles prevent the State of California from requiring higher standards (lower allowable emission rates). There is every reason to make sure that States and localities retain the authority to establish more rigorous standards. National standards will tend to be set at the level acceptable to all interested parties. Locally severe meteorological conditions lead to local requirements which may be considerably more restrictive than those which would be acceptable nationally. The right of local communities to protect the health of their citizens must not be infringed.

Doubtless the coordinated program here suggested is fraught with difficulties from the political standpoint. It is one of the challenges which scientific and technological progress presents to society. The dangers are comparable with those of nuclear war or the population explosion. The solution to all of these problems must be found. The costs of not doing so in time are too great.

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A CONGRESSIONAL VIEW OF THE PROBLEM

GAYLORD NELSON
U.S. Senator
from Wisconsin

As a boy growing up in a small town in northern Wisconsin, I fell in love with the out of doors—of which we seemed to have so much back in Clear Lake.

To a boy, the trees seemed wondrously tall, the hills seemed very high, the waters seemed deep and pure, and the wildlife seemed magically mysterious.

It came as a shock to learn that these wonderful features in our great out of doors were all being threatened by the very progress which we had been taught in school to anticipate with such great expectations. It seemed impossible that anything done by man could actually destroy that wide world of nature. But I have been seeing it happen every day since then.

The biggest thing of all in this world outdoors was the sky. It was the sky I always thought of when they first taught us the meaning of infinity. It was the open air we always wanted to escape into.

Who could have foreseen the day when man would be on the verge of turning the very air we breathe into poison?

But that is the problem we are here today to consider in this historic conference.

Partly because of my background, the urgent need for preserving some significant part of our world of nature has preoccupied me throughout much of my service as a state legislator, as Governor, and as a United States Senator.

Through the past decade of work in this field, I have come to the conclusion that the No. 1 domestic problem facing this country is the threatened destruction of our natural resources, and the disaster which would confront mankind should such a destruction occur.

Air pollution is just one part of the massive threat which faces our resources, all across the country and all around the world.

The same powerful forces which create the crisis of air pollution are also threatening our fresh water resources, our woods, our wildlife, and the scenic beauty of the Nation. These forces are the rapid increase in population, industrialization, urbanization, and scientific technology.

It is now entirely conceivable that these forces set in motion by man will prove so powerful and so irreversible as to destroy the natural environment. This poses a challenge to our system of self-government.

There is a real question as to whether this Nation, which has spent some 200 years developing an intricate system of local, State and Federal Government to deal with the public's problems, will be bold, imaginative and flexible enough to meet this supreme test.

Our governmental system survived two world wars. It appears fully equal to compete with Communism in the struggle for world leadership. But will it be adequate to cope with our own hell-bent drive to destroy our resources?

Before we talk about what government must do to control air pollution, let us just review for a moment what government has already done—or at least what it has allowed to be done—to our environment.

In northern Wisconsin, and in much of the nation, we destroyed our forests. Our own northland once had 200 billion board feet of white pine, one of the greatest concentrations of wealth anywhere in the world. We wiped it out in an eyewink of history and left behind 50 years of heartbreak and economic ruin. Forest fires raged through the slash left behind by the loggers. Crystal clear trout streams silted in. Hundreds of thousands of acres of land became tax delinquent, and local units of government faced economic chaos.

Then we destroyed our rivers. Our cities and our developing new industries converted many of them into sewers, killing their fish, ruining them as a recreational resource, threatening the health of those who use them as a water supply.

At present we are destroying our lakes. Our small inland lakes are being ruined by overdevelopment and by septic tanks, and our mightiest bodies of water such as the Great Lakes are being slowly and steadily destroyed by municipal, industrial and shipboard wastes. Lake Erie is almost gone, the pollution of southern Lake Michigan has been branded practically irreversible.

Stripminers and bulldozers are destroying our natural landscape. Pesticides, now being used at the rate of 700 million pounds a year, are spreading all across the land and the water, poisoning the soil, killing fish and wildlife, and posing a potential threat to human health. DDT is being found in reindeer and in penguins and its concentration is soaring as it progresses up the food chain—from water, to plants, to fish, to birds and presumably to man.

And now the very air we breathe!

Our factories, our automobiles, our public incinerators and our homes are filling the air with noxious gases and dangerous particles of pollutants at a terrifying rate.

Automobiles alone are discharging enough carbon monoxide to pollute a blanket of air 400 feet thick, six miles wide, stretching from New York City to Los Angeles.

Our coal-burning furnaces alone are discharging enough sulfur dioxide to pollute a similar blanket of air, 400 feet high and from coast to coast, 15 miles wide.

Thousands of deaths have officially been traced to air pollution, and many thousands more were almost certainly caused by it. Polluted air is causing or aggravating bronchitis, asthma, emphysema, and lung cancer. It is making people more susceptible to pneumonia. It is making it hard for elderly persons to breathe, and it is interfering with the delicate systems by which the human body filters out irritants and makes use of the vital ingredients in fresh air. It is making it difficult for pilots to see the ground as they fly in to our greatest cities.

Our scientists tell us that air pollution does some $10 to $12 billion damage every year. It damages farm crops as much as 100 miles from the sources of the pollution. It blights pine trees, kills orchards, damages orange groves and grapevines and ruins spinach. It corrodes metals, weakens fabrics, discolors paint, etches glass, cracks rubber, and spreads its filth over everything. It turns white snow black, and it soils wash on the line before it even can be worn.

These are the things we can see with our own eyes, breathe with our lungs, and feel with our hands. But up there in the once blue sky, concealed behind a blanket of smog, things are happening which no average person can detect.

A Cornell University scientist, Dr. LaMont Cole, testified before our Senate Interior Committee on my bill to authorize research into ecology—the relationship of all the different elements in our environment. Dr. Cole said:

> Man is burning fossil fuel at an ever-increasing rate, and it is probable that more than half of the fuel ever burned by man has been burned in this century. One result of this is to release carbon dioxide into the atmosphere more rapidly than it can be taken up by green plants or dissolved in the oceans and eventually precipitated . . . It appears probable that the carbon dioxide content

> of the atmosphere has increased by at least 10 percent since the turn of the century.
>
> Atmosphere carbon dioxide is believed to have drastic effects on climate, and there are now diametrically opposed hypotheses as to what effect this change may have. One hypothesis predicts that world temperatures will increase and melt the icecaps from Greenland and Antarctica, thus raising sea level and drastically altering the world's coastline; for example, all of Florida would be under water. The other hypothesis contends that precipitation, including snowfall, will increase so much that glaciers will start to advance and bring on a new ice age.

The scientists also remind us that this orgy of fuel burning—which stokes the fires of American industries and powers our autos and planes—is using up oxygen at an accelerating rate. Again, Dr. Cole testified:

> The only reason the earth's atmosphere contains oxygen for us to breathe, and with which to burn fossil fuels, is that oxygen is constantly being given off by green plants. If we reach a point at which the rate of combustion exceeds the rate of photosynthesis, the oxygen content of the atmosphere will start to decrease. Almost a year ago I made an intense effort to estimate how near we are to the balance point which will signal the end of expansion of our present type of industrialization, but satisfactory data of the necessary sort do not exist. I suspect that we are close to the critical point, but I shall not try to defend this opinion.

Scientist after scientist offered similar testimony at our ecology bill hearings. For instance, Dr. Bostwick H. Ketchum, president of the Ecological Society of America and associate director of the Woods Hole Oceanographic Institution, testified that, "in the long run, the very survival of mankind may depend on what we do today and in the near future to use and exploit our environment."

As I have emphasized, the crisis of air pollution is seriously complicated by the fact that chemical changes occur in the atmosphere which we understand only slightly and which we have little power to control or even detect. This is true with relatively simple pollutants such as automotive exhausts. Think of the implications for air pollution in nuclear testing!

Two years after water in the western Pacific was contaminated by radioactive fallout, clams were found to contain fantastic concentrations of the radioisotope cobalt-60. Scientists tell us that cobalt-60 is not produced by atomic fission. It must have been produced by the action of radiation on some chemical in the water. These findings involving Pacific Ocean clams showed that dangerous new chemicals can be accumulated in the tissues of animals up to several million times the concentration in the surrounding water.

In the light of such findings, think of the implications for our environment if we were to adopt the suggestion to use nuclear explosives to dig a canal across Central America.

As I indicated earlier, I think the basic question we face is whether our system of government is adequate to deal with these overpowering new problems facing our environment. Can we react to this enormous challenge? Or will we prove to be prisoners of our system, pursuing our traditional routines while problems far beyond our present capacity rise up to destroy us?

Let us take a brief look at what our governments are presently doing about air pollution.

Many of our cities and some counties have developed local air pollution programs. These started out as "smoke control" programs. We know now that the problem is much more complex than controlling local smoke. Relatively few States have strong anti-pollution programs.

The Federal Government's role in air pollution consists of making grants to local air pollution agencies so they can operate their own programs, pretty much as they please.

The Federal Clean Air Act as amended this year makes $46 million available for the fiscal year ending next June, and $66 million for the following year. The States presently are spending slightly over $5 million for air pollution control programs, and communities are spending about $15 million.

While leaving full responsibility for air pollution control programs at the State and local level, the Clean Air Act did put the Federal Government clearly in charge of reducing automobile exhaust pollution. It authorized Federal standards for systems to control auto exhausts, beginning with 1968 models.

To anyone familiar with State and local government, I think the shortcomings of our present national air pollution control program should be obvious.

Air pollution is a massive problem of the greatest urgency. It is utterly unrelated to traditional political boundaries. It can be nationwide, even worldwide, in its effects. It taxes the technical knowledge of our leading scientists. Clearly, this is one public problem which cannot simply be left to local government to handle as it sees fit.

Many of our air pollution problems are *regional* in nature. The boundaries of regional air pollution problems are determined partly by geography, partly by the pattern of air movements, partly by the pattern of urban sprawl.

The most obvious regional air pollution problem is the New York City-New Jersey-Connecticut area. What can the suburban communities in New Jersey and Connecticut do about the mushroom-like cloud of pollution which often envelops Manhattan and all but obliterates the sun on some occasions?

What can city air pollution authorities in Chicago do about the suffocating pollution pouring out of steel mills in that giant, three-State industrial complex at the southern end of Lake Michigan?

Few communities have the facilities to develop proper standards. And private industry should not be faced with widely differing standards from city to city. This creates the old problem of competitive disadvantage and encourages some industries to threaten to move away if tough standards are set.

The rationale for Federal standards on auto exhausts is that cars move from State to State and the problem is the same everywhere. But the smoke from a huge electric generating plant in New Jersey moves into New York just as autos do, and the problem of controlling such emissions is the same regardless of where they originate.

Next, we must admit that despite the increase in our recent authorizations, our financial support for air pollution control is still only a fraction of what it ought to be. If we calculate our losses to air pollution at $10 to $12 billion a year, would it not be worth some sizable portion of that amount to conquer it?

But most important of all is our basic approach to all these threats to our environment. We must see them all as part of a common phenomenon with potentially ruinous consequences for our civilization. For 200 years we have plundered the resources of this continent, thinking that there always would be plenty more where they came from.

That is no longer true. Just as we have completely destroyed many species of wildlife, we now have it within our power to destroy our rivers, our Great Lakes, and even the air we breathe.

As Dr. Sidney Galler of the Smithsonian Institute testified before the Senate Interior Committee:

Throughout the history of the world, various nations have risen and fallen in accordance with overexploitation and deterioration of their resource bases. If we are to avoid the same pitfall, we must provide a scientific foundation for conservation, development and effective use of our resources. It is essential to our survival as a Nation to take effective action on these problems.

We need a broad new program of Federally supported ecological research. With our resources gradually disapearing, with our capacity to destroy the environment growing each day, we must know the impact on our environment of every step we take from now on.

We must know in advance that wiping out forests destroys the soil, ruins lakes and streams, even affects the climate and causes some agricultural crops to die. We must know that digging a canal to the ocean can admit sea lampreys and wipe out our lake trout fishery. We must know that phosphates in detergents will fill our lakes with fast growing algae.

If we are to do these things—if we are to save the natural resources of this land to sustain ourselves and future generations—than we must begin at once to develop the governmental programs and institutions which will accomplish that life or death goal.

QUESTIONS AND COMMENTS

ALLAN A. FISHKIN (*Director of Sales and Service, Morse-Boulger Incinerator Co., Corona, New York*): Who has the responsibility for insuring proper performance of incinerator equipment in New York State?

HELLER: I can only speak for the procedure in New York City. The incinerator industry has a responsibility to sell reliable equipment to meet our performance standards for air pollution control equipment. The city has the responsibility to make clear its criteria and standards to the industry and to approve only those installations which meet our standards.

FISHKIN: The Incinerator Institute of America, comprised of leading manufacturers and designers in this country, have spent millions of dollars on incinerator research. Their facilities and trained personnel should be used to the utmost, not ignored as they have been in so many areas. Dollars must not be wasted on equipment that is not tested or guaranteed by installers. To protect the public, installers should be licensed. Reliable installers will help educate the maintenance personnel. Don't waste the know-how of reliable manufacturers and designers.

HELLER: I quite agree that there may be a need to license equipment manufacturers to meet specific requirements. As a matter of fact, our Department in New York right at this moment has it under advisement.

LEVEE: Will New York State enter into an interstate agreement with the State of New Jersey?

HELLER: I don't think there is any doubt that the problem of air pollution in the New York area is a regional one. Furthermore, I don't think there is any question that, if we are going to be successful in solving the air pollution problem in the area, it will be necessary that all parties concerned, the communities outside the City of New York, those in the State of New Jersey, those in the State of New York, and perhaps those also in Connecticut, must meet on common ground and agree on air quality objectives. They must agree that the objectives must be met in a finite time, so that we may move concurrently to solve our problem. As you know, the City of New York in concert with the State has agreed on a single ambient air quality objective for the city to be met within five years.

May I just explore one other aspect with you? Local Law 14 requires that all fossil fuels coming into the city after 1970 will be required to have a sulfur content (if it's coal or oil) of no more than 1 percent. So it seems axiomatic to me that if the City of New York has set itself a goal to reduce, for example, sulfur dioxide levels to .1 part per million on a 24-hour basis, it is incumbent on our neighbors to move forward at the same pace. In answer to your question as to whether we are ready to reach an agreement with New Jersey, I would say that there is a dialogue under way between the State of New York, the State of New Jersey, the Interstate Sanitation Commission, and New York City.

ALEXANDER Z. PETRI (*Councilman, City of Ecorse, Michigan*): Is the Congress now considering, or will the Senator from Wisconsin introduce legislation directing, the establishment of uniform minimum national air pollution control standards? What is the possibility of establishing such standards in the near future?

NELSON: Good, I hope. I spent a year, or rather, I had one man spend a year, on eight water pollution research programs to aid industry, municipalities, etc., and introduced them in the last session, with the idea of establishing what seemed to me to be ideal programs based on the knowledge we have today, to solve the water pollution problem. Hopefully, we'll get around to that kind of program in the next six or eight years. Then I hope to work in the next session on the air pollution aspect. But there are several others, of course, on the Senate side who are interested. Senator Muskie has done a magnificent job. I think both problems require roughly the same treatment.

I don't think you'll solve the air pollution problem until the Federal Government actually does have full authority to act if there is a failure on the part of States and municipalities to act decisively in meeting the problem. I don't think air pollution will be solved unless there is Federal authority to move in after such a failure and delineate the area, establish the air quality standards, and start Federal, State, and regional hearings designed to reach an agreement on a program to stop pollution and to enforce the agreement through the Federal courts.

I think that authority has to be in the Federal law in order to insure that you get uniform air quality standards set all the way across the Nation. How soon Congress will be prepared to take that step I don't know. They were not prepared to take it on water pollution last session. When a few Congressmen can't breathe, then maybe they will support it.

EMMETT I. DAVIS (*President, Davis & Floyd, Inc., Consulting Engineers, Greenwood, South Carolina*): Should consideration be given to establishing criteria on an industry-wide basis rather than an area-wide basis?

NELSON: You may be referring to the fact that we now know very little about many kinds of pollutants. We haven't reached a very sophisticated status in controlling pollutants out of the automobile, or industrial pollutants of various kinds. I suppose we may have to have different standards depending upon the kind of industry involved and, if that is what you mean, I would say that's probably right. You can't require some industry to achieve a purity of its effluents that's higher than the state of the art that we have achieved.

This leads me to comment that we need a vast amount of research money in this field. One of the failures of the water and air pollution bills is that there is not adequate money for research of all kinds. There also ought to be grants direct to industries and private research organizations in order to develop better pollution control devices.

LEVEE: This morning Mr. Bregman stated that the Illinois-Indiana air pollution control compact has been sent to the Congress for ratification and has been waiting there for two years. Why?

NELSON: I didn't know it was there.

LEVEE: Apparently it has been in the Congress and maybe you could help find out what has happened to it. Do you believe that the regional approach which you suggest is the most effective and most practical way to meet the problem of air resource management as well as to solve problems of air pollution? If so, what steps can be taken to break down the objections to this approach.

NELSON: I think it will require Federal legislation and I think the regions involved should be permitted to proceed on their own. I think we ought to increase the Federal aid. If they proceed in an expeditious fashion on their own, there's no necessity for using the Federal law. If they don't, there is a necessity for using Federal law in the same way that it is now beginning to be used in Federal water pollution conferences on interstate water. I don't think you can manage any resource except on a regional basis, i.e., through the regions affected by it, whether it be a watershed or an air pollution problem.

JAMES L. DALLAS (*Sanitary Engineer, Massachusetts Department of Health, Boston*): Do you think that the Federal Government should establish air quality criteria and recommended air quality standards for air passing from one State to the other, so that the State officials may know and utilize these standards and attempt to comply with them before the Feds take over?

NELSON: Yes, just shortly before. Seriously though, I think it's necessary to have recommended air quality standards. Pollutants do cross State lines and I think the States and regions ought to have an opportunity to proceed on their own on an informed basis before the question of Federal enforcement arises.

LEVEE: It occurs to me now that the engineer from South Carolina, Mr. Davis, was probably suggesting that we should establish nationwide standards for emissions that apply to each industry (paper, steel, chemicals, etc.) just as you have for the auto industry.

NELSON: I think that's correct.

SHIELDS F. LAWHORN (*Kingsport, Tennessee*): What air and water quality standards are being considered? Do they include different controls for different water uses, for example, swimming, boating, fishing, etc.? Or do they call for complete elimination of all toxic pollutants?

NELSON: A number of us have been arguing for some time for water quality standards and there are some in the recent Act. We have been arguing for standards to be established within a State as well as for interstate water. What you would have to do with water (air is a little different) is establish a water quality standard for the watershed, depending upon what kind of a watershed it is.

To take an easy example, if it is now a trout stream, the standard ought to be that you may not be permitted to reduce the quality of that water at all. And if it's a trout stream, one of the factors of the quality of that water is temperature. So, even though you didn't introduce any pollutant at all, heat is a kind of thermal pollutant;

so as to trout streams you cannot introduce anything that will affect the quality, including the temperature of the water.

If you're dealing with an industrial water site and it has been used traditionally and is now being used by industry, you would have to lower your standard for that water. If you've got a powerplant on it, the powerplant heats the water and that reduces the quality of that water even without the introduction of any other kind of pollutant.

So you'd have to take each watershed and set a special water quality standard for it. But that standard, of course, must include a requirement that all municipalities and all industries must have treatment plants that will achieve the highest level of purity that the present state of the art permits; and that's the best you can do. As you increase your knowledge, you would also increase the water quality standard and make the users achieve that.

I agree with you that, as to air, the standard should be that you eliminate every single pollutant that you can, again to the maximum degree the state of the art permits.

Senator Muskie's committee has all this material before it. I'm not on his committee any more, but I think ultimately they will get to that, although, as you know, we are now a long way from a very strong law in the field of air pollution.

STANLEY REDBERG (*Professor, University of Connecticut*): I'm basically an optimist, but I'm very pessimistic about the control of air pollution. If you want to gain support for your program, you should set a good example. Let's be realistic. Nonsmokers will not be too convinced about the sincerity of those who plead for pollution control on the part of others at the same time that proponents of control pollute their immediate environment with cigarette, cigar, and pipe tobacco smoke. I would like to recommend that you send nonsmokers to your legislative hearings.

". . . thirty years of service with Los Angeles Police Department . . .
known as the 'smog sheriff' . . . lecturer at UCLA . . ."

CONCLUDING REMARKS

LOUIS J. FULLER*
County Air Pollution
Control Officer
Los Angeles, California

It is generally agreed that control of air pollution should be the responsibility of the lowest level of government capable of dealing with the problem in its entirety, but it is apparent that no such single level of government exists. Air pollution control is far too complex to be corralled exclusively under Federal, State, regional, or local jurisdiction. It requires the intelligent integration of all the political entities into which our society is organized. The greatest single difficulty in achieving coordination of effort is to prevent these multiple attacks from duplicating or neutraling each other.

The field of air pollution control has made considerable progress in the past two decades, and by experience we have learned to divide the responsibilities into sensible assignments. The prevention and control of air pollution at its source is the primary responsibility of the local government. Motor vehicle control, at least that of our new vehicles, is generally felt to be a Federal responsibility, there still being some confusion about the role of the States. Technical aid and financial assistance appear to be the responsibilities of the Federal and State governments. In the next few years these roles must be defined more clearly and coordinated more closely.

One aspect that needs immediate clarification is that of motor vehicle control. Technology exists for coping successfully with stationary sources, but the present direction of vehicle emission control arouses a sense of deep concern.

The programs now in effect promise, at best, only long-range relief and do not reflect the urgent need for prompt action to protect the great majority of the Nation's population, which today resides in our expanding metropolitan areas. A maximum effort must be made to restore acceptable air quality to these areas of high-density population. As a local air pollution control official, I feel a sense of frustration because the problem, while local in nature, depends for its solution upon the action by a nonlocal level of government. It appears that as this problem continues, as it must, some harsh remedies will have to be proposed and administered.

It is my opinion that unless motor vehicles are controlled more rapidly and to a much greater degree than now proposed, it may become necessary to restrict the number of vehicles operating in and contaminating the air of our metropolitan areas. It is going to take many years to cure the disease, then perhaps we will be forced to invoke a quarantine. It is not beyond the police power of the States to impose restrictions upon the operation of motor vehicles where such operation results in unhealthy or even merely unpleasant conditions. The operation or motor vehicles is a regulated privilege—not a right.

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*Read by Joseph Pollard, Legislative Consultant for the County of Los Angeles.

The police power of a State is an indispensable prerogative of sovereignty and one that is not to be lightly limited. Indeed, even though at times its operation may seem harsh, the imperative necessity for its existence precludes any limitation upon its exercise, save that it not be unreasonably and arbitrarily invoked and applied. It is not, however, illimitable and the marking and measuring of the extent of its exercise and application are determined by a consideration of the question of whether or not invocation of that power in any given case and as applied to existing conditions is reasonably necessary to promote the public health, safety, or general welfare of the people of a community.

The police power is not confined by narrow precedents, which rest upon conditions of the past and do not provide for present circumstances. In response to new needs for protection of public health, safety, morals, or welfare new forms of regulation may be devised. What was at one time regarded as an improper exercise of the police power may now, because of changed living conditions, be recognized as a legitimate exercise of that power.

Consequently, limitations on vehicle operations in densely populated areas may be the only interim measure which can be taken if the increase in the number of vehicles offsets whatever improvement results from the application of currently available control devices. And these control devices may not improve if they are required only to meet standards which represent some sort of national "average" need, rather than the needs of large urban centers with severe problems.

It may appear unrealistic to contemplate shutting off the flow of motor vehicles into congested areas, but when we look ahead to the vehicle population that is forecast for 1980 and the pollution those vehicles will generate, such measures may be our only salvation. There are more than 3½ million vehicles on the roads of Los Angeles County today. In 1980, only 13 years from now, there will be 5½ million. Even if by then the average motor vehicle is producing one-half of the pollution of today's average car, motor vehicle pollution will be greater than it is now. This will be true after devices even more effective than those now required are on almost 100 percent of the vehicles on the road!

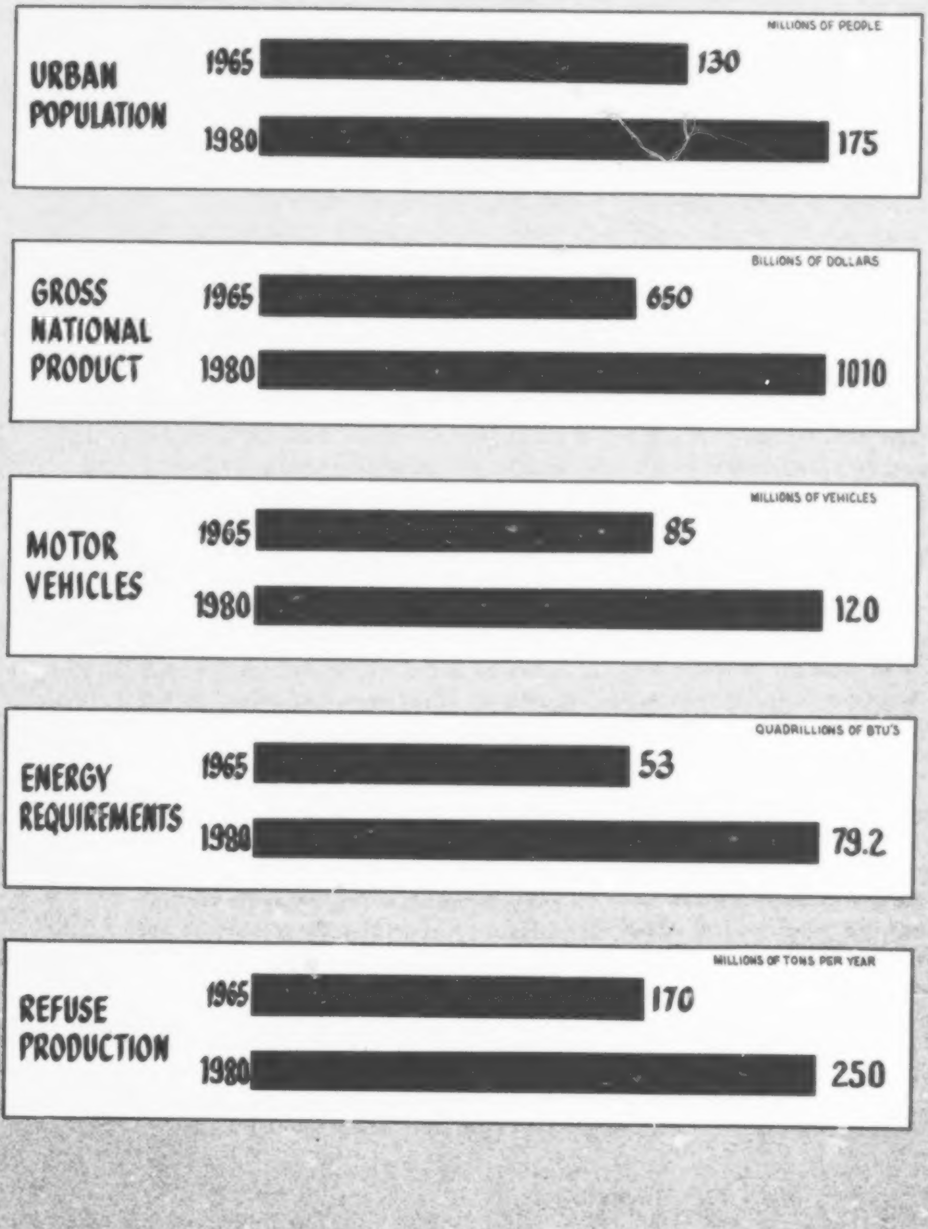
This is not just a Los Angeles problem. It is a problem for every urban area and that means for the overwhelming percentage of our population. Most of the people in this country are presently, or soon will be, suffering from Los Angeles-type motor vehicle smog, even with the presently available types of control devices installed and operating at theoretical peak efficiencies.

This is an appalling prospect and one which must give a compelling sense of urgency to our discussions on how to improve air pollution control programs. Even though the Federal Government has moved into the field of motor vehicle control with commendable alacrity, the problem is increasing more rapidly than the scheduled solution. Obviously, more stringent Federal standards are necessary, but any standards that now seem probable will not meet the immediate need.

How, then, can State and local programs be improved to plug this gap? It is suggested that some limitation be placed on the influx of motor vehicles into heavily contaminated urban zones. The States have the power to do this. Planning should begin at once. Implementation of these plans should follow.

All around us today we see the tide of air pollution rising at an accelerating rate, and as the tide rises, so will the price that communities are willing to pay for survival. Admittedly, restricting the mobility of our automobile-oriented society is a strong demand, but it is typical of the kind of restrictions we are going to have to learn to live with as we place increasing strain upon the inflexible limitations of our environment.

MAJOR GROWTH TRENDS AFFECTING AIR POLLUTION



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December 13, 1966

PANEL G

ROLE OF THE FEDERAL GOVERNMENT IN AIR POLLUTION CONTROL

FIRST SESSION

Chairman William J. Stanley
Director of Air Pollution
Control
Chicago, Illinois

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". . . executive director in charge of research in communications science for Bell Telephone Laboratories . . . served on many advisory bodies, including President's Science Advisory Committee . . . holds two honoray doctorates . . ."

STATUS REPORT

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Federal programs in air pollution began in 1955, when the 84th Congress passed "an act to provide research and technical assistance relating to air pollution control." This legislation supplemented the Public Health Service Act by authorizing the Secretary of Health, Education, and Welfare: (1) to prepare or recommend research programs for devising methods of controlling air pollution; (2) to encourage cooperative activities by State and local governments; (3) to collect and disseminate information relating to air pollution; (4) to conduct research to devise and develop methods of prevention and abatement, and to support such work conducted by other governmental and private agencies; (5) to conduct research, surveys, and investigations concerning any specific problem of air pollution, upon request of any State or local government air pollution control agency; and (6) to make grants to, and enter into contracts with, other governmental and private agencies and individuals for surveys, studies, research, training, and demonstration projects. The Congress appropriated a little less than $2 million to implement the first full fiscal year of this new Federal program, and continued to support its gradual expansion.

In 1958 the President issued an executive order to Federal agencies, directing them to "take such action as may be practicable and consistent with the law, in cooperation with State and local authorities concerned with the control of air pollution, to insure the prevention or abatement of atmospheric pollution caused by or resulting from Federal activities . . ." In 1959 the Congress declared by public law that it was its intention that every Federal installation "to the extent practicable and consistent with the interests of the United States and within available appropriations, cooperate with the Department of Health, Education, and Welfare, and with any interstate agency or any State or local government air pollution control agency in preventing or controlling the pollution of the air."

In 1960 the Congress passed the Schenck Act, which directed the Surgeon General of the Public Health Service to conduct a thorough study and to report as soon as practicable on the amounts and kinds of pollutants that could be discharged from motor vehicles without endangering human health. A report entitled "Motor Vehicles, Air Pollution, and Health" was published in 1962.

By 1963 the annual Congressional appropriation to implement the Federal air pollution program had increased to $11 million.

In December 1963 President Johnson signed into law the Clean Air Act, which considerably broadened the role of the Federal Government in air pollution control and strengthened its ability to assist and participate in a comprehensive national effort. In addition to expanding upon the research, technical assistance, and training activities of the 1955 legislation, the Clean Air Act included several new provisions of national significance:

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*Presented by William J. Stanley, Director of the Department of Air Pollution Control for the City of Chicago.

1. A directive for the development of air quality criteria for the guidance of State, regional, and local air pollution control agencies in protecting the public health and welfare.
2. Authorization for Federal financial grants to State, regional, and local agencies to assist in the cost of establishing, developing, or improving air pollution control programs.
3. Authority for a limited participation by the Federal Government in the legal regulatory control of interstate air pollution, and, upon request of a State, control of intrastate air pollution.
4. Several new authorities relating to the conduct or support of research, including directives to work for the development of (a) improved techniques for removal of sulfur from fuels; (b) processes and prototype devices for the control of air pollution; and (c) projects with the automotive and fuel industries for the development of automotive pollution control.

The Clean Air Act reiterated the Congressional policy that the States and local governments have the primary responsibility for the regulatory control of air pollution and made the further finding that Federal assistance and leadership were essential for the rapid development of the broad programs needed to control air pollution.

In October 1965 President Johnson signed Amendments to the Clean Air Act, one of the most significant provisions of which directs the Secretary of Health, Education, and Welfare to prescribe standards of the emission of any substance from new motor vehicles that may be injurious to the public health or welfare. In March 1966, the Secretary of Health, Education, and Welfare issued such standards and made them applicable to all gasoline-powered passenger cars and light trucks, starting with the 1968 models.

The standards require significant reductions in emissions of hydrocarbons and carbon monoxide, two of the principal types of air pollutants discharged through motor vehicle exhaust tailpipes, as well as 100-percent control of hydrocarbon emissions from the crankcase.

In addition to granting authorization to the Secretary of Health, Education, and Welfare to regulate motor vehicle emissions, the 1965 Amendments authorized the Secretary to investigate and hold public conferences on potential air pollution problems, to be held in places where a potential air pollution discharge may be expected to affect adversely the public health or welfare. If the Secretary finds evidence that a pollutional discharge would be likely to contribute to an air pollution problem subject to abatement under the Clean Air Act, he is authorized to send his findings and recommendations both to the persons responsible for the potential air pollution source and to all control agencies in the affected area. These findings and recommendations become a part of any formal abatement action taken under the Clean Air Act. The Secretary's recommendations while only advisory, can exert a strong influence on those planning to undertake potential air pollution activities subject to control under Federal law.

The 1965 Amendments also extended the abatement authority of the Clean Air Act of 1963 to cover air pollution problems arising in the United States which may pose a health or welfare hazard for persons in neighboring countries. Whenever he is advised by a duly constituted international organization or by the Secretary of State that air pollution arising in the United States is adversely affecting persons in foreign countries, the Secretary of Health, Education, and Welfare may invoke the abatement authority granted in the Clean Air Act.

Action may lead to a suit in United States courts to secure abatement if steps short of this, as provided in the Clean Air Act, fail to achieve satisfactory results. The new legislation stipulates, however, that any foreign country which claims the right to seek abatement of an air pollution source in the United States must accord this country a reciprocal right to seek abatement of sources within the foreign country's borders.

In May 1966, the President issued an Executive Order requiring that emissions from Federal installations be minimized if they are likely to be injurious or hazardous to people, animals, vegetation, or property, and that emissions which endanger health or welfare not be permitted. The Secretary of Health, Education, and Welfare was directed to provide technical advice and assistance to the heads of other departments, agencies, and establishments to assist them in complying with the order, and to prepare standards for the emissions of pollutants from Federal installations. The order also required that all new Federal buildings and establishments have provisions for controlling the emissions of pollution, and that plans for the control of emissions from existing installations be prepared by July 1967.

In June 1966, the Secretary implemented the executive order by issuing standards applicable to virtually all Federal installations. These standards are designed to limit the emission of pollutants coming from the combustion of fuel, the storage and handling of fuels and ash, the disposal of refuse, and other pollution-producing processes. The standards apply to both existing and future installations; they specify permissible levels of emissions and require that suitable measures be taken to monitor these levels.

In November, in compliance with a stipulation in the standards issued in June, the Secretary proposed sulfur oxides standards for Federal installations in the New York, Chicago, and Philadelphia metropolitan areas. The proposed standards, recognizing differences among the three communities in the severity of the sulfur oxides problem, require more restrictive measures in the New York region than in the other two.

In October of this year Congress passed additional amendments to the Clean Air Act, a major provision of which authorized Federal grants to State and local agencies to assist them in maintaining effective air pollution control programs; this supplemented the authority provided in the original Clean Air Act for awarding of grants to promote the development, establishment, or improvement of such programs.

The funds available for the Federal air pollution program have been steadily increasing. Appropriations under the Clean Air Act, as amended, reached $35 million in fiscal 1967. The 1966 Amendments authorized appropriations of up to $46 million for fiscal 1967, $66 million for 1968, and $74 million for 1969.

Both public concern with air pollution and the Federal program have grown at a rapidly increasing rate. We are here to think together and to report to the public and the Congress about some of the decisions that the Federal program might make in the near future and about some of the needs and dangers that must be faced.

". . . assistant surgeon general in charge of PHS programs of disease prevention and environmental health . . . Harvard M.D. and M.P.H. . . . for six years associated with PHS air pollution programs . . ."

AIR QUALITY CRITERIA AND STANDARDS

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In my experience, discussions of the development of air quality criteria and standards have usually taken one of two courses. Either they have been so academic that they never touched the real issues or they have been so diffuse that they produced more heat than light. In either case, they have provided no realistic basis for action. I hope that we can avoid these pitfalls this morning, for the development of air quality criteria and standards will require a great deal of action in the months and years ahead.

I am not aware of any serious disagreement as to the need to develop such criteria and standards; indeed, they are widely regarded as an essential element of programs for the prevention and control of the very complex air pollution problems we have today. They offer a means of dealing rationally and equitably with problems which have been and, for the most part still are being dealt with mainly on a pragmatic basis. For this reason, the derivation of criteria based on the effects of air pollution, the subsequent establishment of air quality standards, and finally the fixing of appropriate emission limitations, constitute a logical and widely acceptable approach to the challenge of air pollution.

This approach certainly seems simple and straightforward, but putting it into practice requires recognition and solution of a number of problems of fundamental importance. It is my intention, this morning, to try to bring some of these problems into focus, and to examine some of the ways in which they might be worked out.

To begin with, I think we need to look at the ways in which the development of criteria and standards is currently being approached.

In the Clean Air Act, which is, of course, the basic legislative authority for the Federal Government's air pollution program, the Secretary of Health, Education, and Welfare was assigned the responsibility for developing and publishing criteria based on the effects of air pollution. To provide a frame of reference let me quote the Act's provisions regarding criteria: "Whenever the Secretary determines that there is a particular air pollution agent or combination of agents present in the air in certain quantities, producing effects harmful to the health or welfare of persons, the Secretary shall compile and publish criteria reflecting accurately the latest scientific knowledge useful in indicating the kind and extent of such effects which may be expected from the presence of such air pollution agents or combination of agents in the air in varying quantities. Any such criteria shall be published for informational purposes and made available to municipal, State, and interstate air pollution control agencies. He shall revise and add to such criteria whenever necessary to reflect accurately developing scientific knowledge."

A further provision authorizes the Secretary to recommend those criteria which, in his judgment, may be necessary to protect public health and welfare.

It is clear that the Clean Air Act called on the Federal Government to develop criteria, but left standard-setting up to the State and local governments. This is based on the assumption that standard-setting is related to enforcement, which, under the Clean Air Act, is also a function that State and local governments are expected to perform. The assumption is that those agencies which enforce the standards should set them, and vice versa. To see how this is likely to work out in practice, I think we must first try to clarify the terms involved.

Air quality criteria are, in essence, an expression of the relationship between air pollution and its adverse effects on man, animals, vegetation, and property. The criteria we are developing under the Clean Air Act will indicate what the scientific literature shows with respect to the nature and extent of the injury associated with the occurrence of specific levels of pollutants during various time periods.

Our criteria will, of course, indicate the lowest level of exposure at which specific effects have been found to occur. This means that the criteria will reflect scientific evidence pertaining not only to so-called normal, healthy adults, but also to those individuals and groups, such as the elderly and persons afflicted with chronic respiratory diseases, who may be particularly sensitive to certain adverse effects of air pollution.

It is important to recognize that criteria are not synonymous with standards; perhaps this seems obvious, but in my experience the distinction is very frequently overlooked. As prescribed by the Clean Air Act, air quality criteria are being developed on the basis of a thorough evaluation of the best available scientific knowledge. They are intended to serve as guides for the development of air quality standards, but, unlike standards, they are not legally enforceable.

To provide a basis for rational and practical control action, the establishment of ambient air standards is the first step to be taken. The next step, indeed, the key step in setting the stage for enforcement activity, is the development of emission standards applicable to individual sources of air pollution. The purpose of such standards is, of course, to keep total pollution from all sources within the applicable standards of air quality. To achieve and maintain such air quality standards, it is absolutely necessary to develop and enforce legal limitations on emissions from the sources of air pollution.

A rational and truly effective program for the control of air pollution must include all of these elements: scientific knowledge of the effects of air pollution, preferably, though not necessarily, expressed in the form of air quality criteria; a consensus on desired levels of air quality, expressed in the form of air quality standards; and legally enforceable limitations on emissions from individual sources of air pollution. And then, there must also be enforcement action.

Once air quality and emission standards have been established, enforcement can be essentially a routine function, but in the absence of such standards, dealing with every instance of uncontrolled air pollution is a new and difficult struggle.

And yet, under our present national policies concerning the prevention and control of air pollution, we expect State and local governments to bear nearly this entire burden. To be sure, the Federal Government has a responsibility for developing criteria.

The first such criteria, which concern sulfur oxide pollution, are about to be issued. Others will follow. The preliminary work on criteria for oxidants is near completion now.

Inevitably the criteria will reflect the fact that relatively low levels of the common air pollutants are hazardous to human health. They will show, in effect, that the levels of air pollution which many American communities commonly experience represent a serious threat to the health and welfare of all the people living in these communities. Certainly, this will not be a revelation; at least, it should not be.

If there is a public health official or an air pollution control officer in this room or anywhere in this country to whom such an appraisal of the air pollution problem comes as fresh news, then he has been ignoring facts that have been accumulating for years.

It is important that air quality criteria be viewed in their proper perspective. They will not be a panacea for all the ills that beset the field of air pollution control. To be sure, they will summarize many data on the adverse effects of air pollution; but the data themselves, I might add, are already available in the scientific literature.

In any case, the fact that criteria have not been available has not prevented at least a few States and cities from developing air quality standards. And conversely, the fact that criteria will soon be made available will not insure the development of such standards by the rest of our States and cities.

Currently, State and local governments are expected to develop and promulgate air quality standards, which means, of course, that they must find ways of dealing with all economic, social, and political problems inherent in the standard-setting process.

Then they are expected to develop and promulgate emission standards for individual sources of air pollution, which usually means that they will have to fight the same battles over again. And finally, if they can manage to adopt standards, they are then expected to enforce them.

In practice, this approach places on State and local agencies a burden which in many instances may be too great for them to bear.

To succeed in adopting meaningful air quality and emission standards, they must, of course, be able to enlist wide support from the industry and from the public. But the fact is, that gaining such support is difficult in the absence of any assurance that other States and communities will adopt standards of commensurate effectiveness.

Difficulties in establishing uniform standards discourage the creation of viable regional control programs. Unless government officials at the local level can insure both industry and the public that adequate standards enacted locally will be matched by similar standards in adjoining communities, it is not realistic to expect much support from either. Local industries cannot be expected to support strongly standard-setting activities that may impose a competitive disadvantage on them in relation to similar industries in other communities. For somewhat similar reasons, State or local control officials find it difficult to convince the people they serve that they should provide increased tax revenues to support control measures which are not being taken by neighboring States and communities.

To be sure, there are some people in government and industry who would defend the present system. They would cite the undeniable fact that air pollution problems are somewhat different in every community.

They would cite the fact that activities under the Clean Air Act have already produced a substantial degree of progress toward improved control efforts in our States and communities, and there is indeed a great deal of truth in that. And, among other things, they would maintain that those agencies of government which are charged with enforcing air quality and emission standards should also have the responsibility of setting those standards.

But many other people in government and industry are becoming increasingly dissatisfied with this approach and are seeking alternatives.

The one which is probably mentioned most often involves assigning greater responsibility to the Federal Government, insofar as standard-setting is concerned. This would mean, presumably, that action could be taken to establish uniform national standards of air quality, as well as emission standards for important sources of air pollution.

A number of persuasive arguments can undoubtedly be advanced in favor of such an approach. Federal standard-setting would mean, for example, that State and local officials would not have to swim upstream against the currents of industry and public opposition to unilateral adoption of air quality and emission standards. They could, instead, concentrate on enforcement activity, which, purely as a practical matter, can probably be accomplished most effectively and efficiently at the State and local levels of government.

I do not think anyone can logically argue that Federal involvement in standard-setting would eliminate either the economic and political or the social and technological factors that have a bearing on the prospects for effective control of air pollution; indeed, they cannot be ignored if we are to reach broadly acceptable solutions to the air pollution problem.

What can be argued, however, is that standard-setting on a national scale would make it possible to give such factors their proper weight in relation to the public need for protection against air pollution.

A final argument that can be made in favor of standard-setting on a national scale concerns the desirability of implementing uniform control measures across the country. This applies most obviously, of course, to the establishment of air quality standards.

I think it is obvious, for instance, that levels of air pollution which are harmful to health and damaging to property in one community are no less harmful in every other community, no matter where or what the source of pollution is. I doubt that anyone would suggest that the extent of a citizen's right to enjoy a wholesome and healthful environment depends on where he happens to live.

An equally good case can undoubtedly be made for uniform emission standards applicable, at the least, to those sources of air pollution which are nationally significant.

To be sure, there may be room for some degree of variation in emission limitations, depending on such factors as meteorology and the concentration of sources in a single geographic area.

In general, however, air pollution control problems are essentially alike in all parts of the country. By and large, control measures which are technically feasible for a particular stationary source of air pollution in one community are no less feasible elsewhere.

In the long run, it can be argued, the adoption of uniform emission standards on a national scale will inevitably accelerate wide application of the best available control technology, and in turn, stimulate research to make such technology more effective and less expensive.

I have tried, in these few minutes, to summarize some of the more cogent reasons that are being offered in support of a new look at the way in which we approach standard-setting in the field of air pollution control.

I hope that other members of this panel and those of you who participate in the open discussion will pursue this subject further. I am sure we can all agree that the problems facing us with respect to standard-setting are not easy ones to deal with. And yet, these problems must be solved if we are to succeed in mounting a truly effective national control effort.

With the problem of air pollution threatening to reach critical proportions unless we take decisive control action, we cannot afford to fail. But I am afraid that we will fail if we continue trying to attack the complex air pollution problems of the 1960's with the smoke abatement weapons of the 1940's or the nuisance abatement weapons that many governmental agencies are still relying on.

We will fail, I think, unless we find ways of insuring the development of adequate air quality and emission standards for the entire country.

"... meteorologist ... sanitary engineer ... expert in air and water pollution problems ... head of California's air sanitation programs ..."

DISCUSSION

AIR QUALITY CRITERIA AND STANDARDS

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The paper on air quality criteria and standards reviews the current activities of the U.S. Public Health Service and concludes that the Federal Government should establish uniform air quality standards for nationwide use. This conclusion is reached on the basis that local agencies have largely failed to act in this area and that the setting of standards would be a difficult task for these agencies.

The increasing attention being given to the subject of air quality criteria and standards is a result of the expanding efforts to deal with the air pollution problem. Standards state air quality in quantitative rather than qualitative terms and establish specific goals when designing control programs involving numerous sources, kinds of pollutants, and effects. They describe the contaminants of concern, state the air quality desired by the community, and provide a basis for determining the degree of control required to achieve this air quality. They can promote effective communication on the air pollution problem and needed control programs among the control agencies, those discharging pollutants, the public, legislative bodies, and the press.

In the absence of accepted standards, the parties involved in the control of air pollution tend to adopt their own guides for satisfactory air quality which can range from very low to relatively high levels of air pollution. Standards cannot be expected to bring about complete agreement on needs for air pollution control. They can, if based on satisfactory data, bring about a much closer consensus than if there were no standards.

As greater and more effective effort is made to control air pollution, additional emphasis must be placed on the establishment and use of quantitative air quality standards. A clear understanding of the required degree of control becomes necessary as the means of control become available and as control programs are implemented. We have only to look at water pollution, another problem in waste disposal, to see an even more intensified effort in the adoption of environmental standards. Also, we can observe here an established pattern of Federal, State, and local responsibility in the development and use of water quality standards for interstate and coastal waters.

Obviously, air quality standards are not a magic answer to all air pollution control problems. They tell you where you want to go, but not much about how to get there. Standards, themselves, raise many problems and questions. Most of these arise from the difficulty of prescribing precise numbers for contaminant concentrations that cause the various effects and from the lack of adequate data on effects experienced at given concentrations of contaminants or combination of contaminants. Much of the difficulty that state and local agencies face in adopting air quality standards can be traced to the lack of data on which to base and support the standards.

If air quality standards are to be of maximum value to a control agency, they must include all the pollutants that cause the problems in the community, and they must be based on criteria which are accepted by the scientists and technical people of the community. Standards that appear to be arbitrary will not be accepted as a sound basis for the control program. One of the first and most important needs, therefore, is for air quality criteria relating the effects to be expected from specified concentrations of contaminants.

The Federal Government, because of its resources, has the central role and the greatest contribution to make in the area of criteria. The individual States should not be required to duplicate the effort and expense of acquiring the data required to develop criteria. The need for criteria and the important role of the Federal Government in this area have ready been recognized by Congress. The absence of criteria has been one of the reasons for the failure of local agencies to adopt air quality standards. It would be interesting to be reviewing the progress in setting of standards had criteria been available for several years.

Although air quality standards are important in air pollution control programs, the absence of standards probably should not be blamed for the lack of viable regional control programs. The lack of success in establishing such programs is due to more fundamental factors, such as the apathy of the public and the failure of government and civic leaders to promote and support regional programs.

Dr. Prindle states that an equally good case can be made for uniform emission standards. Uniform air quality standards and emission standards are somewhat inconsistent concepts, because uniform air quality implies that emission standards can vary depending on the quantity of emissions and meteorological conditions in each area.

Widespread use of air quality standards would encourage air pollution control programs. It is not clear, however, that nationwide standards would be the most effective way to bring about air pollution control, when one considers the nature of the air pollution problem, the purpose and use of air quality standards, and the fact that local agencies have the major responsibility to enforce control of air pollution. Air quality standards are usually taken to mean numerical values adopted by a governmental agency, to be used as the basis for controlling air pollution. Such standards may include factors of safety or other modifying factors which reflect social, economic or technical considerations.

In some instances air quality standards would have very broad or nationwide application. This is expected to be the case for contaminants which may cause illness or death in humans. One nationwide standard may be logical and reasonable for standards based on the health of humans. In many cases it is desirable to permit flexibility in standards to provide for local desires and situations. Most air pollution problems are concerned also with nuisance, esthetics, and economic loss. The problem may be one of visibility, discoloration, odor, damage to some species of very sensitive crops, soiling of buildings, or paint blackening. The problem may also be caused by a single source or a few sources, involving a limited area and a small number of people, in contrast to a community-wide problem in a large metropolitan area. In these cases one standard cannot apply nationwide, and it is proper that local communities have some voice in deciding the air quality they desire. A residential community of high-priced homes or a recreational area may desire much better air quality than a large metropolitan area.

It is possible, of course, for the Federal Government to establish standards according to regional or local situations. This, however, would be a large task and would require studies and hearings in local areas. A set of such standards would not achieve the goal advanced in the paper for a uniform nationwide approach for all agencies and discharges of pollutants.

Standards should be adopted by a level of government which has the legal authority to see that they are implemented. The existence of national standards will not in itself insure the development of local programs to provide air quality meeting the standards. There is Federal authority over air pollution from Federal installations, interstate areas, and motor vehicle emissions. It is not clear how the Federal Government would implement standards in cases of intrastate air pollution. What happens when a local area fails to establish a control program or even to evaluate its air quality in terms of the nationwide standards?

If maximum effectiveness in air pollution control is to be achieved through the use of air quality standards, methods must be devised to make their use mandatory rather than optional by communities with air pollution problems. This can best be accomplished by the adoption of standards at the State level of government. At the same time, new State laws would be needed to insure that the air quality in all regions of the State would conform to the standards. These laws should permit local agencies to enforce air pollution control regulations and provide for State intervention only when the air quality standards were not being met.

SUMMARY

1. Air quality standards provide a valuable tool in the control of air pollution. Their use will increase. If the water pollution field is any indication, Congress will seek means to require wide use of air quality standards in the control of atmospheric pollutants.
2. Uniform nationwide air quality standards should not be adopted for all pollutants. There must be a recognition of the many different situations that exist and the desires of local communities. Uniform air quality standards imply differing rather than uniform emission standards.
3. All levels of government—Federal, State and local—have an interest in air quality criteria and standards. The Federal Government has the key role in providing criteria. Success in setting standards will depend on the availability of sound criteria.
4. The Federal level of government has a direct concern with standards because of interstate air pollution, motor vehicle emissions control, and emissions from Federal installations. However, it is not the most effective level of government for dealing with intrastate problems and for implementing air quality standards at the local level.
5. Effective air pollution control is not only hindered by the lack of air quality standards, but also by the lack of methods or laws for insuring that the standards, once adopted, are implemented.
6. The adoption of air quality standards for interstate areas affected by air pollution might follow the pattern established by Congress for water pollution control.
7. The State is the most effective level of government to deal with intrastate air pollution problems and to take the steps to implement air quality standards. States, however, must accept the responsibility to establish standards and enact the legislation that will insure implementation of the standards in the various regions of the State.
8. Local agencies seldom will have the resources which are required to define criteria and adopt comprehensive air quality standards. They are the agencies, however, which will carry out the control programs needed to provide air quality that meet the standards.

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FEDERAL ROLE IN EMISSION CRITERIA AND STANDARDS

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Air pollution, occurring across the Nation as it does, is a proper topic for the Federal Government to take cognizance of. The Federal Government has become involved in determining its nature, causes, and cures, and in eliminating interjurisdictional problems that involve State boundaries.

In most cases, however, air pollution exists as isolated instances of limited range and its regulation is logically within the police power of the States. While the Federal Government can engage in regulatory activities in interstate and international cases, its intrastate role is limited. However, industries of national character, such as automobile manufacture and atomic energy, are examples of the kind of situation in which the Federal Government may take the dominant role.

It follows that the actual adoption of emission standards (that is, their endowment with legal status in regulatory legislation) will in most cases be by the States and their subdivisions. Federal activities are, as we will see, at once constrained and imperatively required.

Before proceeding further, let me ensure that we are all thinking about the same question by defining "emission criteria" and "standards." *Criteria* are any factors which should be taken into account when judging an emission. Standards are those factors which have been set in the form of definite rules or measures by the proper authority. Generally, standards are in terms of measurable properties of the pollutant emission, such as its quantity per unit time, its concentration, its color, its opacity, perhaps the height of the emission, and perhaps in terms of suitable means of measurement. In short, they tell us what is permitted to come out of the smokestack or the tailpipe. *Standards* are the language of action. They give the emission operator a useful, unequivocal target which is directly related to the source operation. Industry does need some target to shoot for. Control officials, too, can function strictly within their enforcement powers, without the need for quasi-legislative or quasi-judicial deliberations over what constitutes pollution or whether extenuating circumstances should be considered.

Standards mean that the arguments have been heard, the decisions made, the votes cast. They indicate that society now requires conformity or will permit exceptions only after due legal course.

On the other hand, criteria are the voices of conflicting demands. They may tell us that the emission should be judged in terms of its effects and that we should control only to the point of no effect: or that there should be no pollution allowed, regardless of whether unwanted effects are proved, or that there must be technical feasibility to limit the emission by control equipment or alternative processes or devices: or that there must be economic feasibility, taking into account the desire to conserve investment capital and to maintain a favorable competitive position so that we should control only to the limit of economic comfort: or that local factors of terrain, industrial density and meteorology are more or less favorable compared with other locations.

Somehow these demands must be satisfied and the conflicts resolved. Thus, when standards are established, it is implicit that decisions have been made regarding all pertinent criteria, and that compromises must be involved.

Who will make the compromises? Who might develop the emission standards and what has been done so far? Trade associations and professional organizations have gratuitously proposed standards and model ordinances. Consultant and research organizations can be retained. And, of course, the governmental agencies through their staffs and advisory bodies, have the final responsibility for developing these bases.

At present, very few emission standards are in effect as legislation. Particulate matter is limited by opacity, generally based on the Ringelmann scale, or by concentration based on variants of the Model Ordinance of the American Society of Mechanical Engineers, or on variants of the Allegheny County Code, or based on some process weight variant of the Los Angeles County Code. Standards for specific particulate composition, that is by chemical composition, or for specific industries, aside from the California automotive and hydrocarbon limitations, include little beyond a 2,000 part per million standard for sulfur dioxide.

We obviously need standards for many more specific emissions. How are we going to get them? They could be set by some of the non-governmental bodies mentioned before or by the Federal Government, and then could be adopted by a state or local government. But the originators must do a complete job of investigation, come to an optimum conclusion, and report the entire process. Only then can the adopting body decide that it would have come to the same conclusion; otherwise, there would be an abdication of legislative responsibility.

I think, however, most local and State elected representatives will insist on doing their own standard-setting. We must also remember that, except for cases in which there exists a reliable air quality criterion, and in which it is agreed that control will be based on the elimination of effects only, there is no purely logical basis for standards upon which we will all agree. What it comes to is that we can obtain all the control we wish for a price, but there is difference of opinion as to how much pollution we should have, how much to spend to eliminate it and whose money is to be spent.

For problems of this sort, we must turn to our elected representative bodies. They, in turn, seem to be looking back to us. The legislature with the burden of decision needs authoritative advice on ambient air quality requirements, the technical feasibility of control, alternative methods or substitutes, economics, measurement methods, atmospheric dispersion, and other matters of fact.

The legislature must decide whether clean air is every man's right or a luxury to be purchased or given. It must decide if it should act now to protect the Nation's health, at the risk of endangering investment capital before all of the effects are absolutely known. And it must decide if the desire for esthetic factors and the conservation of a beautiful environment are suitable bases for control. (The dramatic phraseology is intentional; standards are not set on the basis of fact alone.)

Even after legislation has been passed, the debate is not over. There are several points in the enforcement process where the argument is reopened and the facts are reexamined. Whenever the administrator makes quasi-legislative or quasi-judicial decisions, or there are requests for variances, or there are appeals ot review boards or court cases, there is a re-evaluation of standards.

What, then, is the proper role of the Federal Government? Certainly it is on safe ground to perform studies and to give technical advice. Many local and State governments are not capable of the task of providing the basis for standards, nor would it be sensible to have this done 50 times. Nor could it be done in reasonable time that way. The Federal Government has the resources to do what is necessary through its agencies and outside contracts. As a start, it could suggest nationwide minimum standards based on current technical feasibility and the economic considerations peculiar to each source and thereby strengthen the position of local control agencies who must cope with threats based on alleged regional economic differentials.

The Federal establishment can also set a good example in its own installations. Where it has jurisdiction for control, Federal standards will be set. However, there is a real danger that Federal standards which are undocumented will be copied without proper understanding. Certainly, any model ordinances and standards published by the Federal Government must be completely supported by reports on the evaluations involved.

I suggest a program which would provide the necessary information in the proper way. To give local programs the ammunition they need, it would have the objective of setting forth all of the substantive information needed to evaluate emission criteria and to formulate emission standards. This includes the following points:

1. *Air quality criteria must be satisfied.* This requires information on effects of air pollution upon biological systems, on materials, on esthetic qualities, and economics.

2. *Technical feasibility must exist.* This requires information on basic processes and equipment, indicating the intrinsic character of emission generation aspects. Alternative processes, machines and materials should be described and compared on any points of significance. Control equipment should similarly be discussed in complete and critical fashion.

3. *Economic feasibility must exist.* This requires a thorough knowledge of source and control economics, which will provide meaningful parameters, such as control cost per unit of production or per dollar of profit, control capital investment per unit of total capital investment, and various measures of profitability, such as return on investment, discounted cash flows, etc. It must generally be possible to evaluate whether control cost is significant or not; whether it is greater than the cost of moving operations to another location; and what will be the resulting increase in costs of products or services to be paid by the public.

4. *Methods for measurement must exist.* This requires information on all available pertinent sampling and analysis methods, their capabilities, costs, and relative merits. We must have a technical basis for enforcement.

5. *The experience of other jurisdictions should be consulted and consistency should exist where reasonable.* This requires knowledge of the criteria and standards developed and the bases for them, as well as a critical evaluation.

The final product going to State and local governments will be manuals on each of the above criteria plus an overall summary and guide. The guide should present both general principles and example standards based on representative philosophical and economic positions and premises. For instance, one would like to know what is the cost of complete control, or the cost of the required service or product by an alternative manufacture or means, or the emission standard and cost to just meet ambient air quality criteria (if these are known). Further, one would like to know what standard can be maintained at a cost of 1 percent of product value, or 1 percent of added value by manufacture, or 5 or 10 percent of profit before taxes. Or, perhaps the most meaningful kind of economic measure for this situation is: What standard would be consistent with a decrease in return on investment, or interest rate of return, of perhaps 5 to 10 percent? In short, give the people who really have to make the decision some real figures on what can be bought for what price.

Preparation of these manuals should be coordinated by the Federal Government and should involve both in-house and non-governmental work. Considerations of staff and time requirements augmented by the desirability of a non-aligned organization point to the use of contract work by universities and research organizations to lead the task force and to prepare core sections for the manuals. These core documents would be based on all information available in the literature, plus that generated by any necessary original studies, and would be complete, independent statements.

Professional, trade, governmental, and other organizations should be invited both to contribute to the core documents and to comment upon them. Final reporting of the core statements and commentaries in the published manuals should be extensive rather than an edited consensus. Dissenting views should be published in the manual along with the core or central position. Only in this way can the ultimate users, the legislators, be given all the facts.

Nationwide air pollution control can be given a great impetus by supporting local action with knowledge. But mere numbers, standards without explanation, without documentation, are not sufficient. Things would be a lot simpler for air pollution control officers and for plant design engineers if there were nationwide emission standards. There would be no question of one region competing with another on the basis of easier emission standards.

But this can't be done now. Perhaps someday it will be argued that the only way to sustain local control programs in difficult locations is to have uniform standards. We may come to the conclusion as a nation that we should conserve the purity of air resources, regardless of whether there is a known harmful effect, and that therefore we should control all air pollution sources to the maximum possible point.

Until that day and also to prepare us for that day, we can accomplish much by developing the complete bases for judging each important source of pollution. It is clearly a job for the Federal Government. It is imperative that the Federal Government act with restraint—but act.

". . . engineer on DuPont's team for air pollution control in plant facilities . . . past chairman of Mid-Atlantic APCA section . . . chairman of air quality subcommittee of Manufacturing Chemists Association . . ."

DISCUSSION

FEDERAL ROLE IN EMISSION CRITERIA AND STANDARDS

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I value this opportunity to discuss Dr. Calvert's paper. It is well done. His proliferation of thought-provoking concepts indicates his serious effort to come to grips with what I believe is and will continue to be a highly controversial activity—to wit, the role of the Federal Government in emission criteria and standards.

I certainly agree that air pollution is indeed a national problem and one that must involve considerable Federal effort. The recent smog episode that covered a substantial portion of our eastern seaboard during Thanksgiving week indicates that air pollution can occasionally breach in dramatic fashion the boundaries of separate governmental jurisdictions.

If we are to cope successfully not only with the dramatic but infrequent smog episodes, but also with the more usual day-to-day air pollution situations, much more effort will have to be expended.

No one group has a corner on all the knowledge needed to solve this complex problem. Its magnitude indicates that if we are to expedite solutions, the effort should be divided up and spheres of activity delineated for industry, the public, the local, state, and interstate air pollution abatement agencies. The Federal role should, and by act of Congress will, be highly important to the ultimate success of conquering our society's air pollution problems.

Fundamentally, this whole situation of air pollution has come about in the first place because the air that we have been breathing has started to smell, to dirty and corrode property, to harm crops, to offend our esthetic senses, and to threaten the health of at least some members of our society. In brief, the quality of our ambient air is no longer acceptable in all places and at all times.

If the air is unsatisfactory, then there is some condition that can be defined as satisfactory. Since there are, of course, degrees of satisfaction ranging from barely acceptable to highly exhilarating, we are faced with some compromises. We must define goals, however, if we are to proceed in an orderly manner. I also submit that if maximum progress is to be attained we should put our time, energies, and money on those measures that will yield the highest results.

The response of the various receptors is what really determines the quality or condition of the ambient air. This is obviously a function of the type, quantity, and source characteristics of the contaminants discharged into the air and the meteorological dispersion conditions available at a given time.

Dr. Calvert has clearly enumerated the various factors which should be considered in developing stack emission criteria to provide the bases for setting legal emission standards. He pointed out that emission standards give the operator a goal and the enforcement agency a yardstick to measure compliance with the law. Ideally, these are valid and convincing arguments. I also not only agree, but feel it is a mandatory responsibility of all interested and affected groups to present their case fairly to legislative bodies and control agencies so that they can formulate realistic legislation and regulations.

The specific question before us is: What is the Federal role in emission criteria and standards? In the Clean Air Act, the word "emission" is used five times. It is used three times in reference to automobile exhaust; once in regard to research to develop low-cost techniques designed to reduce emissions of oxides of sulfur from combustion operations; and a fifth time in reference to the Department of Health, Education, and Welfare obtaining source data for Federal conferences. My own interpretation of these points indicates that Congress has not, either specifically or by inference, directed the Secretary of Health, Education, and Welfare to develop emission standards for stationary sources for any but Federal installattions. On the other hand, Congress was specific on two other points. Congress stipulated that the prevention and control of air pollution at its source is the primary responsibility of the state and local governments. Congress also unequivocally directed the Federal agency to compile and publish criteria, accurately reflecting the latest scientific knowledge useful in indicating the kind and extent of effects harmful to health and welfare of the people.

There are enough jobs in the air pollution field to keep many groups busy; a division of effort is indicated. One activity that the Federal agency can probably perform better than any other group is in the development of ambient air criteria which Congress has mandated. Many more facts and scientific investigations are needed to perfect our knowledge of the behavior, characteristics and effects of contaminants in our environment. Obviously, we cannot wait for all these facts to be determined before doing anything. The millions of dollars already spent for control indicate that we have not been waiting, but the availability of more extensive ambient air information will increase our knowledge of what problems are the most important, will pinpoint the emphasis, and increase the justification for the control measures taken. If the States and local communities have available the criteria for protection of health, the odor thresholds, the effects on vegtation, etc., they can tailor their local control of emissions to provide the desired degree of protection.

My only plea to the Federal agency in its role of establishing ambient air criteria is that while it be bold and imaginative, it should also be restrained within the bounds of present knowledge on its first tries. After all, this is a continuing business and the limits set today must be reviewed as we go along and changed later as our experience and knowledge increase.

As a case in point for this philosophy, I commend the approach of the American Conference of Governmental Industrial Hygienists, who revamp and update their criteria periodically.

While it may appear that I propose a closed door to the Federal agency in regard to emission criteria and standards, this is not entirely the case. The official regulations for control and abatement of air pollution from Federal installations refer to basing the design needs on ambient air criteria, on land use, and on meteorological, topographical, esthetic, and operating factors. While these items are not necessarily new, their emphasis at the national level provides a valuable service in setting a tone of realism and in emphasis on the scientific approach. This is one role the Federal agency can play in emission criteria. Consideration of these factors is commended to local and State regulatory agencies in developing their own emission criteria and standards.

Another area where the Federal agency can influence emission standards is in the service of encouraging, developing, and supporting broader air monitoring coverage. It is my view that the only way we can truly evaluate accomplishments, note trends and emphasize additional control needs is to vastly expand air monitoring networks. The aid provided by the Federal agencies in this program will enable the States and municipalities to judge more accurately what emission limits are needed.

The Federal agency can also provide a better basis for local groups in setting emission standards by the extension of dispersion models, tracer studies, and the use of computer programs in cooperating and helping coordinate local and regional studies. These will highlight the really broad and important problems, the local contributing sources and enhance the local efforts in establishing realistic emission limits. The key to providing satisfactory ambient air is to relate it to the source emissions. These areas of Federal activity should improve this technique.

There are two emission regulations which have gained considerable popularity among regulatory agencies and are being proposed in many localities at present. The record should be set straight on them, and I recommend that the U.S. Public Health Service should consider doing it.

One is the type modeled after Rule 54 in Los Angeles, which regulates fumes and dust. This regulation is a table that relates the process feed in pounds an hour to the allowable stack discharge to atmosphere in pounds an hour. There is no mention of stack height requirements or the toxic effects of the dust or fumes on people, or the effect on property or vegetation. This is an arbitrary regulation which may or may not attain the desired goals since at least two important concepts are missing. Such a regulation may satisfy the needs of Los Angeles, for example, but in my judgment such an arbitrary approach is not recommended for proliferation nationwide.

Rather, a more imaginative approach is needed, taking into account stack height, the contaminant's effects, and the local needs.

A second regulation is the 2000 ppm in-stack concentration approach for sulfur dioxide. In some localities, this applies to both combustion and non-combustion operations and in others only to the latter. This regulation has no technical merit or promise of necessarily providing the desired degree of ambient air quality. It says, in effect, that a source discharging only 20 lb./hr., but at an in-stack concentration of 3000 ppm represents a more serious air pollution threat than a source discharging 2500 lb./hr., but at an in-stack concentration of 1500 ppm. This concentration-type regulation is unscientific and does not recognize many manufacturing operational characteristics. It is inflexible in not acknowledging the variability of control needs for different areas. As written, this type of regulation is frequently not accompanied by any specification for the stack height required or any consideration of source location. I doubt that anyone would appreciate living near a unit discharging 2500 pounds an hour of sulfur dioxide and at a concentration of 1500 ppm if the stack were only 75 ft. high. It would meet the legal limit; but I strongly suspect that the local control agency's telephone would do a lot of ringing!

Truly, this popular regulation should be clarified, and a scientific approach applied, based on mass emission rate, stack height, and the ambient air quality needed. Only in this way do we gain a true evaluation of a source's potential. Only in this way do we face up to the hard decisions that certain new sources simply can no longer be located in some areas.

Air pollution is a complex problem. Oversimplification of emission regulations, while administratively easy, can backfire in terms of missing the real mark—the control of our ambient air. Through its educational function, the Federal Government can point out unrealistic emission regulations of the type I have just mentioned.

I disagree with Dr. Calvert's statement that we obviously need standards for many more specific emissions. Nor can I agree that the Federal Government should set national minimum standards. Like a definition of the average man, such minimum standards may not typify any practical situations, being unduly restrictive for some areas and not sufficiently restrictive for others.

Dr. Calvert has raised the point that uniform emission standards might be justified on the basis of preventing one company in a less restricted control area from having a competitive edge over another which manufactures the same product in a more strictly controlled area. Academically, this is too complex a matter to answer without a thorough study and it may vary from one product to another.

Overriding this, however, is the basic concept that the control agencies would be departing from their field of air pollution control based on need and into what is, in effect, governmental managing of the economy and subsidy technology. I suspect this is a field not for air pollution agencies, but for Congress. It is better that we define what air pollution control measures we really need for a given area and then face up to doing something about it.

Dr. Calvert has stressed the desirability for more knowledge on the economics of air pollution control programs, including their effect on investment return for various manufacturing operations, and the costs on relocating some operations. Industry, of course, soon learns these cost facts when it analyzes its requirements in order to comply with a new regulation.

Occasionally, industry has sufficient time to produce this information before a public hearing date. But even when there is time, industry is frankly reluctant to discuss the costs that a proposed regulation would entail because of the bad image this has induced in the past. I think there is merit in developing more factual data on control costs, their effect on the economy, and the resultant benefits. Performing these studies ahead of time and outside of the public hearing spotlight can lead to more orderly, dispassionate, and realistic appraisals on which intelligent action can be taken.

Certainly, the Federal agency could be the spark to bring such studies about and to define the general framework for action, but industry should be an active partner in any such studies and should have initiative and flexibility in the details of implementation. Universities and private research organizations could be of great value in such efforts.

In summary, I do not feel the Federal agency should take an active role in setting stack emission criteria or standards. However, their indirect activities in setting ambient air criteria; in improving and extending air monitoring programs; in increasing the technology on broad scale dispersion models and computerized programs; and in pointing out ill-conceived types of emisson standards, can make the Government the catalyst for the States and local communities to effectuate more scientific emission standards to do the real job needed.

Again, may I commend Dr. Calvert for his fine paper. He and I are not far apart on many of the points he has raised. Certainly, we both agree that the Federal Government has a worthy role to play in helping assure that our air resources are preserved.

". . . scientist and educator in field of air resources . . . former professor in Cal. Tech's environmental health engineering laboratory . . . over 20 years with the U.S. Public Health Service . . ."

FEDERAL ABATEMENT OF MAJOR INTRASTATE AIR POLLUTION SOURCES

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The average person reacts unfavorably to the idea of Federal control of air pollution within the boundaries of a State. Most of us are conditioned to the concept that Federal agencies should keep out of State matters, and that any involvement on their part in purely local affairs is an unwarranted intrusion and a violation of the principle of State's rights. It is relatively simple to marshal a number of convincing arguments, based on practical and ideological considerations, pointing out why such Federal activities are inherently wrong and why they should be avoided at all costs.

It may come as a surprise to many individuals to learn that the Federal Government is in fact already active in intrastate air pollution abatement and indeed has been for some time. Moreover, for the most part such involvement has been beneficial, and, in specific cases, indispensable.

My principal effort will be to review the many modes in which the Federal Government has become increasingly involved with abatement of atmospheric pollution within State limits. In several instances, participation by the Federal Government is indirect, and the implications are not very obvious. In others, however, the participation is direct, clear, and on a major scale.

PHILOSOPHY OF CONTROL

It is the basic stated policy of Congress "to preserve and protect the primary responsibilities and rights of the States and local governments in controlling air pollution." However, this statement does not necessarily imply that the Federal interest stops at this point; indeed, it extends well beyond it. It is a further policy of the Congress to assist the States and local governments in achieving the desired degree of air pollution abatement. In many cases this assistance is in the form of technical and financial support. The nature of some types of air pollution problems, however, is such that only the Federal Government can provide the best solutions. In these cases mere support and encouragement are insufficient.

I shall analyze existing Federal laws with the objective of demonstrating the implicit and explicit authority granted by Congress to Federal agencies to engage in intrastate abatement of air pollution. My illustrations will show the ways in which this power is utilized in unique and special pollution problems.

FEDERAL INVOLVEMENT IN LOCAL AIR POLLUTION ABATEMENT

The question whether the Federal government should or should not engage in intrastate abatement of air pollution is somewhat academic. As mentioned previously, Congress has already granted to the central government authority which, though limited, nevertheless permits it to engage in a wide spectrum of control activities on the State and local level. The nature and magnitude of this authority can be shown by a chronological review and analysis of Federal laws enacted within recent years.

The Federal government first entered the arena of air pollution control in 1965 with the passage of Public Law 159, known as the Air Pollution Control Act. The act specifically recognized the primary right and responsibility of the State and local governments in the control of atmospheric pollution. The Federal role was limited to the conduct of research and technical assistance. The act contained no provisions for Federal abatement activities. It must be pointed out, however, that for several years following the passage of PL 159 a number of community air pollution studies were conducted by the Public Health Service in close cooperation with State and local governments. The objectives of such studies were to define the nature, sources, and extent of the problem, and to assist in the establishment or improvement of State and local control programs.

An important end-product of these technical studies was the formulation of recommendations for achieving satisfactory abatement. Thus the central government played a key role in the promulgation of many control programs which the States and local agencies willingly accepted.

THE CLEAN AIR ACT

The passage of the Clean Air Act (PL 88–206) in 1963 represented a significant evolution in Federal policy on atmospheric pollution. For the first time the central government received from Congress legal regulatory authority to abate air pollution problems. This new power was intended to supplement the powers of State and local governments in dealing with several specific situations in which they were powerless to act.

Section 103(c) of this Act directs the Secretary of Health, Education, and Welfare to compile and publish criteria information relative to the adverse effects that may ensue from exposure to the various air pollution agents. Such criteria of air quality may be recommended for use by municipal, State and interstate air pollution control agencies.

Information of this type will no doubt greatly influence the local authorities in the establishment of air quality standards for their areas.

Section 103(e) of the Clean Air Act contains a provision which authorizes the Secretary of the DHEW to investigate and hold public conferences in those places where potential air pollution may develop into a situation dangerous to public health or welfare. The objective of this provision is to prevent significant new air pollution problems from arising.

If such an investigation reveals that a real threat exists, the Secretary is authorized to submit to the offender and all responsible persons his findings and recommendations. While such recommendations are only advisory, they can exert a strong and beneficial influence on the abatement of pollution in the local area.

Section 104 of the Clean Air Act gave to the Secretary authority to make grants to State and local air pollution control agencies for the purpose of "developing, establishing, or improving programs for the prevention and control of air pollution." These grants make it possible for State and local governments to conduct studies designed to evaluate their air pollution problems and to draft rules and regulations for abatement.

To qualify for such financial assistance these control agencies must meet certain legal, financial and program requirements. Technically, the granting mechanism provides the Federal Government with an opportunity to exercise some control over the number and types of local abatement programs.

Admittedly the grant-in-aid provision of the Clean Air Act offers only a remote possibility for the Federal establishment to interfere in the normal conduct of State and local abatement programs.

Section 105 contains a provision which empowers the Federal Government to intervene not only in interstate problems which cannot be solved by a single State, but also in intrastate problems under specified conditions.

The intrastate abatement procedures consist of a time sequence of conferences, public hearings and finally court action. The abatement action is terminated if the problem is solved after the first or second step of this sequence. It must be borne in mind that the intent of this provision is to assist the state and local authorities in dealing with cases which, though intrastate in nature, are too difficult for them to handle.

In cases where the health and welfare of persons in a State are alleged to be endangered by air pollution, the Secretary of Health, Education, and Welfare may call a conference. He may do this provided he is requested to do so by the governor of a State, a State air pollution control agency,

Authority for Federal participation in intrastate air pollution abatement

Title of act	Federal law	Date	Section	Pertinent provisions
Air Pollution Control Act	Public Law 84–159.	1955	....	Congress declares its policy of preserving and protecting the rights of States and local governments in controlling air pollution, and of providing research support and technical assistance in abatement.
Clean Air Act...	Public Law 88–206.	1963	103(c)	The Secretary of Health, Education, and Welfare may recommend to State and local air pollution agencies criteria of air quality necessary to protect public health and welfare.
			103(e)	The Secretary may call a conference and make recommendations to State and local agencies in order to prevent potential air pollution problems.
			104	The Secretary is authorized to make grants-in-aid to air pollution control agencies for developing, establishing, or improving prevention and control programs.
Clean Air Act...	Public Law 88–206.	1963	105	The Secretary is authorized, when requested by a Governor or authorized State and municipal agency, to initiate procedures to secure abatement of intrastate air pollution.
			107	Requires all Federal agencies to cooperate with Health, Education, and Welfare and State and local control agencies in preventing and abating air pollution.
Clean Air Act Amendments.	Public Law 89–272.	1965	202	The Secretary of Health, Education, and Welfare is authorized to prescribe emission standards for new motor vehicles.
			[1] 102(a)	The Secretary may invoke abatement authority to control air pollution arising in the United States and adversely affecting individuals in a foreign country.
Executive Order 11282.	....	1966	....	The order directs all Federal agencies to prevent, control, and abate air pollution from their facilities.
Clean Air Act Amendments.	Public Law 89–675.	1966	3	The Secretary may authorize grants to State and local agencies to insure continuance of approved air pollution control programs.

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[1] Now in sec. 105 of Public Law 88-206.

or a municipal government which has first cleared through the governor and the State air pollution control agency. Following such a conference, the Secretary submits to the control agency a report outlining the existence of a problem, adequacy of existing abatement measures, and the nature of delays in abatement. If, after at least six months, the Secretary feels insufficient progress has been made towards a solution of the problem, he recommends to the control agency the necessary remedial action to be taken.

If adequate remedial action has not been taken within six months, the Secretary calls a public hearing before a board appointed jointly by his office and the state agency. The hearing board on the basis of all the evidence presented determines whether the problem exists and whether satisfactory progress towards abatement is being made. It can then make recommendations to the Secretary concerning measures which it considers reasonable and appropriate to achieve abatement. These recommendations are then sent by the Secretary to the control agency.

After six months, if abatement action has not been taken, the Secretary at the request of the governor provides technical and other assistance to the State to assist it in judicial proceedings to secure abatement under State or local laws. Or, at the request of the governor, the Secretary requests the Attorney General to bring suit on behalf of the United States to secure abatement. A Federal court then reviews all the accumulated evidence and "shall have jurisdiction to enter such judgment, and orders enforcing such judgment, as the public interest and the equities of the case may require."

There have as yet been no cases of this type. The procedure is long and expensive. Moreover, it is conducive to embarrassment and poor public image for the polluting source, the State and the control agency. It would appear that this fact alone provides a strong deterrent to most State and local parties. The threat of ultimate Federal suit should be an additional source of discouragement for the more recalcitrant violators.

Section 107 of the Clean Air Act contains a provision requiring all Federal departments and agencies to cooperate with local air pollution agencies by controlling their emissions to prevent air pollution. This provision is primarily intended to abate intrastate pollution originating in a Federal facility. The Secretary of Health, Education, and Welfare has established a set of regulations and permit systems to be followed by all Federal facilities.[1]

CLEAN AIR ACT AMENDMENTS

An important section of the Clean Air Act (PL 89–272) passed in 1965 authorizes the Secretary of Health, Education, and Welfare to establish standards of emission from motor vehicles. Atmospheric pollution from automobiles, trucks, and buses has been recognized for some time as being a major problem of metropolitan areas. As the density of motor vehicles increases in urban centers, the resulting uncontrolled emissions from this source can be expected to increase and further aggravate the environmental pollution problem.

In the broad sense, motor vehicle pollution is an urban problem, and, in most cases, strictly an intrastate problem. Impetus for this legislation on motor vehicle pollution control came from serious photochemical air pollution first encountered in the Los Angeles basin.

The magnitude and frequency of this form of urban pollution have grown to such an extent throughout the United States that feasible methods of abatement are beyond the legal, technical and economic capabilities of local pollution control agencies. For many years this problem remained a most difficult and challenging one. The State of California did the pioneering work in this field, and only recently succeeded in achieving a major objective, namely, pollution controls on motor vehicles sold in their State.

Recognizing that motor vehicle pollution was a burgeoning problem of all urban areas, Congress empowered the Federal government to attack this problem on a national scale. The new legislation provides for the development of emission standards intended to control the contaminants discharged by all types of motor vehicles. These standards will go into effect this year on 1968-model cars and light trucks and will provide automobile manufacturers with design criteria for producing motor vehicles with greatly reduced potential for polluting the atmosphere. From time to time such standards will be revised and enlarged.

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[1] This is discussed on p. 484.

Because motor vehicles may move freely from State to State, Congress felt justified in dealing with this source of pollution on a national basis. Though the pollution is largely confined to a local metropolitan area, the enactment of Federal legislation providing for uniform national control has obvious legal and technical merits.

The follow-up task of determining whether motor vehicles which initially meet the standards continue to conform to the emissions standards throughout their operating life is left up to the States.

Another provision of PL 89–272 authorizes the Secretary to invoke his abatement authority to control air pollution arising in the United States and adversely affecting individuals in a foreign country.

It is conceivable that the Federal government can become deeply involved in the control of sources which normally fall within the jurisdiction of the State or local control agencies. Close cooperation between the Federal, State and local agencies will be needed to deal effectively with international air pollution problems.

As stated earlier, the Clean Air Act contains a provision which requires all Federal organizations to cooperate in the control of air pollution arising from their facilities. In May 1966, the President signed Executive Order 11282 entitled *Prevention, Control and Abatement of Air Pollution by Federal Activities.* This order requires Federal facilities to control the emission of pollutants which may endanger the health and welfare of man and his property. It also directs the Secretary to provide technical advice and assistance in this effort. The order further specifies that Federal facilities shall conform to state and local air pollution standards.

In June 1966, the Secretary promulgated a set of guides known as *Performance Standards and Techniques of Measurement,* intended to assist Federal agencies in meeting their air pollution control responsibilities. This document, for example, specifies performance standards on combustion units in terms of Ringelmann number and maximum emissions of particulates and sulfur oxides. Other provisions deal with stack height, fuel storage and refuse incinerators.

It is of interest to note that the standards also specify that if a State or local standard is not prescribed for a particular locality, or if the State and local standards are less stringent than the standards prescribed by the Secretary of Health, Education, and Welfare, the standards established by the Secretary shall apply.

Since about 350,000 buildings are owned by the Federal government, it is obvious that this program of prevention, control and abatement of air pollution from Federal activities will immeasurably assist the states and communities in attaining their goals of clean air.

CLEAN AIR ACT AMENDMENTS

Amendments to the Clean Air Act passed in 1966 as PL 89–675 provide the Secretary of Health, Education, and Welfare with additional funds to help support the continued maintenance of recently established State and local air pollution control programs. This program reflects the Government's concern with the seriousness of local air pollution problems and its intent to provide the assistance needed to achieve control efficiently and without delay.

This legislation carries with it the clear implication that Congress does not intend to stand by while the Nation's air resources deteriorate because of inability or unwillingness of the State and local governments to come to grips with the problem.

CLEAN AIR PRINCIPLES

As stated again and again, it is the philosophy of Congress that air pollution be controlled at the lowest feasible level of government. This is in keeping with the sound principle that the basic responsibility of providing satisfactory health, education and welfare programs rightfully belongs to State and local governments.

Many States have assumed their responsible role in the protection of the air resource. In most of these, control authority has been largely delegated to local governments—cities and/or counties. However, in one notable exception, California, the control of automotive pollution abatement has been retained, for sound reasons, at the State level. California pioneered in this field, and many other States are considering following the California example.

There is sound logic in the principle of local control, the chief argument being that abatement programs should be fitted to local needs, desires and resources. In a Nation as vast and complex as the United States, where economic, social and meteorologic factors vary widely, it is obviously difficult if not impossible to achieve effective and satisfactory centralized air pollution control at the Federal level. In fact, it is even doubtful if optimum intrastate control is always possible at the centralized State level.

There are several other good arguments in favor of maintaining control at the State and local levels. These have been adequately presented by others here and there is no need to review them. We should, however, give more attention to reasons which may justify current and possibly additional Federal involvement in air pollution problems which lie wholly within a State.

It is apparent to most informed persons that the intensity of air pollution is growing at a faster rate than efforts to control the problem. More effective and imaginative measures must be taken if this Nation is to overtake and reverse this trend. The question is, who is to provide the dynamic leadership for the needed forward thrust? If the State and local governments continue to lag in their pollution control efforts, undesirable consequences can ensue, and air quality will deteriorate to critical levels.

Aroused local citizenry will lose its patience and begin to press unreasonable demands. Resulting control actions may be based more on emotion and expediency than on calculated need. The end result could be chaotic. If and when such a situation begins to emerge, we may anticipate that the Federal government will feel obliged to enter the scene and provide the needed leadership which local governments could not or would not provide earlier.

It is difficult to predict what form of action the Federal government would take in this hypothetical case, but it is quite likely that it will encroach further in the realm of intrastate abatement. It is not unreasonable to expect that in the future the Federal government may extend its control of air pollution sources to include those private facilities which have Federal grants or contracts. In addition, it is conceivable that public works financed with Federal funds may come under some form of government control. These could include urban renewal projects, public housing, highway construction, mass transit, and community facilities planning.

Whether this sort of development is desirable or undesirable is open to argument. I would hope that there would be no need for this to happen. On the other hand, I would prefer some form of constructive action rather than the inaction which inevitably leads to further environmental deterioration. Unquestionably, my first choice is effective and reasonable local action now to forestall the need for further Federal involvement later.

CONCLUSION

For the long run, what is most desirable is the immediate establishment of a strong partnership between the Federal Government and the States and communities.

The latter groups should be represented by all sectors of the economy—private interests, general public, as well as the official agencies. No one group can do the job well by itself. They all need one another. In such a partnership each member must be sensitive to the goals and needs of the others.

On the one hand, the Federal Government is charged with the responsibility of protecting the natural air resources of the country in a manner which promotes public health and welfare as well as its productive capacity.

On the other hand, each State and local government has the responsibility of providing its citizens with the proper physical, social and economic environment in a manner best suited to the peculiar situation in its specific location.

A mutually satisfactory solution can be effected if the interaction between these two viewpoints is optimized to yield the most beneficial results in terms of clean air for all the people. This calls for a spirit of mutual understanding, cooperation, dedication, and leadership; of a degree perhaps never heretofore encountered in the public affairs of this country.

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". . . chemical engineer. . . . industrial research, especially in air and water pollution . . . developed processes for producing organic chemicals . . ."

DISCUSSION

FEDERAL ABATEMENT OF MAJOR INTRASTATE AIR POLLUTION SOURCES

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Dr. Rossano has advocated a partnership between Federal and local governments in the control of air pollution, and this seems to be a popular philosophy which has been expressed by many speakers at this conference. Most people would probably agree with this concept, but there may be some disagreement concerning how this concept should be applied. I am therefore going to discuss some specific examples of jobs that need to be done to control air pollution, and make an effort to assign these tentatively to various levels of government. It is fine to talk in generalities and to stress the desirability of a partnership, but I would like to look at some specific examples to illustrate how this partnership can work effectively.

The very nature of air pollution problems and the tasks which must be performed in controlling them makes it desirable that some of these problems be handled by State and local agencies. In many cases, the nature of the problems dictates the level of government which can best perform each specific task.

My examples will be drawn from the present control programs in the State of Texas and from my experience as a member of the Texas Air Control Board. The basic principles, however, would apply in any State or in any political jurisdiction.

The Constitution makes it quite clear that international or interstate problems are the responsibility of the Federal Government: with this there can be little or no disagreement. Matters of foreign affairs, international trade, international health, etc., are clearly the responsibility of the Federal Government.

On the other hand, it appears logical for the State government to undertake such jobs as issuing vehicle licenses, controlling the highways, and taking care of other police activity relating to motor vehicles. Since automobiles can easily cross city and county boundaries, these responsibilities have been assumed in most cases by the State governments.

A man who attempts to rob a corner drugstore or gas station may find himself confronted by a local police officer who derives his power and authority from the city or the county. A local authority is needed who can be on the spot immediately to react to an emergency situation. A police agency with headquarters in the State capitol or in the National capitol is much too far away to provide the necessary police protection.

In the case of police powers, there are well-established divisions of responsibility between Federal, State and local governments, which result from the very nature of the tasks which must be performed if adequate police protection is to be provided for all citizens.

In the field of air pollution control, one might be tempted to seek an easy solution by applying political labels. One might say, for example, that the "liberal" philosophy dictates strong centralized authority and the "conservative" philosophy dictates supremacy of local authority. This is a seemingly easy solution and, like most easy solutions, it has its pitfalls. The most obvious is that it is hard to define just what is "liberal" and what is "conservative." I hope that the important question of establishing responsibility for air pollution control can be settled on the basis of the types of problems that exist without regard to partisan political labels or considerations.

As one specific example of a task which needs to be performed to control air pollution, the Federal Government should and obviously does have authority where air pollution exists at an international boundary or a State boundary. State and local governments on both sides of this boundary can get together on a cooperative or a voluntary basis, but obviously the Federal Government possesses the ultimate authority. This is recognized in the Clean Air Act and in other legislation.

Another necessary job is the conduct of research and development, and this again can be done most efficiently and effectively by the Federal Government. The basic scientific principles which control the reaction, movement, and effects of contaminants in the atmosphere are the same in any location. For State or local agencies to take the leading role in basic research to study these phenomena would involve a needless and expensive duplication of effort. The basic research and development required to produce the knowledge required for setting criteria and for establishing standards to control air pollution can and should be carried out or supported by the Federal Government.

Still another job which has been and should be performed by the Federal Government is the setting of standards to regulate air pollution from motor vehicles. With our modern methods of mass production, much greater economy can be achieved if all vehicles sold throughout the country are engineered and manufactured to meet the same standards. If different State-controlled agencies or thousands of local agencies were to adopt different standards for the control of air pollution from motor vehicles, the manufacturers would face a chaotic situation in trying to comply. Ultimately, the motoring public would have to pay a considerably higher cost to control air pollution from vehicles, and, in fact, the cost might be so high that control for all practical purposes would be impossible!

On the other hand, it would seem to me that the same arguments for national standardization are not valid for stationary sources of pollution. Standards and regulations should meet local requirements if effective solutions are to be achieved at minimum cost. Southern California and a few other areas in the nation need the strictest standards which can be enforced, and obviously they should proceed with such standards to the maximum extent possible. In other areas, more favorable weather conditions or a lower population density make it possible to achieve a reasonable degree of control with standards that are somewhat less restrictive.

An important factor here is the desire of the residents of a State or a community for a particular degree of control. Some States are sensitive to the tourist industry and may demand the utmost in air pollution control, even if this degree of control cannot be completely justified by studies of public health or property damage. If it is the wish of the people of that State, it should be their privilege to have this degree of control. On the other hand, other States or communities may be oriented toward industrial operations and may wish to avoid undue restriction of industrial growth. Again, if this is the wish of the people of that State, they should have an air pollution control program consistent with that wish—provided, and this is a big *if*—provided adequate protection for health and property is achieved. This must be the minimum requirement in all cases.

These variations from one State to another would be much more difficult to achieve if the major authority and responsibility for air pollution control were vested in the Federal Government. A State agency is more sensitive to the wants and desires of the residents of a particular State and can develop a control program most likely to meet those needs and desires. Another advantage of a State agency is that it is familiar with the industries in a State, the meteorological patterns which exist, and the geographical and political boundaries within the State. All of these are important in planning and implementing an effective program.

If the Federal Government were to become active in setting air quality standards and emission standards, I would suggest that, instead of a single set of standards, it might be possible to consider a range of standards requiring different degrees of control. The relative costs and the advantages of these different levels of control could determine the standards for a particular State or community. Or, as an alternate, minimum standards could be established to provide basic protection for health and property, and then individual States or communities might adopt more restrictive standards if they feel that such are warranted, and if desired by the people in the State.

The conduct of surveys and studies to provide scientific information is also important to aid in setting standards and to provide the basis for a control program after the standards have been adopted. This is one of the logical activities of a State agency, which can make available to communities and industries the scientific and engineering skills needed to interpret and apply the standards. A State agency can plan and conduct scientific studies effectively and can interpret the results to industry and to the general public. It can do this without some of the duplication of effort that would be involved if all local jurisdictions were required to work without State assistance.

Still another job for a State agency to consider is the carrying out of surveys and enforcement actions in rural areas or small towns which cannot support separate agencies or which do not need a control agency on a full-time basis. Even in such areas, an air pollution problem may arise occasionally, and a State agency represents the most economical method of providing services.

Just as the Federal Government has the power to intervene in interstate matters, so also the State government generally has the power to intervene in matters affecting one or more counties or municipalities. In this situation, the chances of air pollutants crossing political boundaries are greatly increased. The Federal Government must be concerned with interstate matters involving all States, or at least the 48 that are geographically contiguous. However, in Texas, there are 254 counties, and 586 cities and towns with populations of over 1,000. Some counties have many incorporated cities and towns within the boundaries of a single county. So we see that air pollution can cross political boundaries, not only at the State border, but also at the political boundaries which exist within a State. A State agency, familiar with local personalities, industries, taxing authorities, and governmental entities should be the best agency to achieve the necessary compromise and to establish and supervise regional programs.

The pattern which I have been discussing here is that which has been developing in the nation. It provides for the division of authority and responsibility between Federal and State governments based on the nature of the various tasks to be performed, and assigns each task to the level of government best fitted to meet that particular responsibility.

There are many precedents for this division of authority. The Federal Government frequently conducts research and development, provides assistance to States, sponsors demonstration projects to illustrate new methods and technology, and provides for data collection and dissemination. But in many cases, part or all of the authority for actual implementation of programs is left to State and local governments, together with the authority for any enforcement or regulatory actions which may be necessary. This division of authority is seen in the control and regulation of oil and gas production, in urban planning and urban renewal, in the protection and utilization of forest resources, in watershed protection and flood prevention, in water resources and planning and water pollution control, and in solid waste disposal, among other areas of governmental activity. Thus, the principles which I have enumerated to establish a division of authority and responsibility in the field of air pollution control follow well-established principles which have been applied successfully in many other areas of governmental activity.

To carry this one step farther, in Texas the delegation of responsibility extends also to the local level. The Clean Air Act of Texas established a Statewide program to discharge the duties suggested here for the State agencies. This act also provided for the existence of local control programs, provided they are not inconsistent with the State program. The Texas Air Control Board has interpreted this to mean that the State Board should set standards and establish general guidelines for controlling air pollution in the State of Texas, and should also provide technical assistance where possible. However, at least some of the local enforcement action and investigation of complaints should be carried out by local agencies. Exact details of how this is to be accomplished have not yet been determined because the State program has only been in existence for a few months.

The Board feels that there is adequate justification for this division of responsibility. Just as the State Highway Patrol with headquarters in the State capitol cannot apprehend the burglar at the corner drugstore quickly enough, so also a State board, with headquarters in the State capitol, cannot react quickly enough if a housewife finds that her prize flowers are withered or that the laundry on her line becomes dirty from a local air pollutant. In cases of this kind, an immediate investigation is needed, followed by immediate action where indicated. This can best be furnished by a local agency, usually city or county.

The many problems in controlling air pollution and the many tasks which must be performed, *by their very nature*, establish principles which indicate the appropriate level of government to perform these various tasks. For some responsibilities, this appropriate level will be Federal; for some, it will be State; and for some it will be a local city or county government. I am confident that an adequate study of present and future problems will indicate where the authority and responsibility should reside.

It is also important to note that any authority or any privilege carries with it a corresponding responsibility to use it wisely. This means that if State and local governments want to do the best job possible of controlling air pollution, they must take action before the intiative passes by default to some other level of government. There can be no argument with the fact that air pollution must be controlled. The only questions for discussion concern the type of control effort needed and the manner in which this effort is to be expended.

As Governor John Connally of Texas said about controlling air and water pollution, "Texans have been among those standing for State's rights. We must be equally vocal about State's responsibilities. But talk is not enough. Talk is empty chatter without the programs to meet the needs of our people."

The Texas Air Control Board believes that the activities outlined here for a State agency can be conducted best at the State level. We are determined that these activities will be conducted as vigorously and as effectively as possible, in response to a clear mandate from the Governor and the State Legislature.

QUESTIONS AND COMMENTS

WILLARD ANDREWS *(Assistant to the President, Experimental Biology Division, Becton Dickinson and Company, Rutherford, New Jersey):* Several private research centers exist in the United States today which can place their facilities at the service of the Federal Government in order to set the standards we have been discussing. How should these people proceed if, at the moment, the law places the responsibility for the standards in the hands of State and local governments?

PRINDLE: First, I don't believe that in the kind of a governmental organization we have in this country, we would ever be in the position that private agencies of this type would be actually setting the standards. I think such private-agency laboratories can be extremely useful in providing the scientific knowledge, the evaluative materials, and some of the judgment, that will assist in the establishment of criteria and lead to the development of standards, but I do not believe that we would actually delegate this authority to a private organization.

There is no question as to the usefulness of this kind of organization; certainly, we in the Federal Government contract with and utilize private research laboratories, as well as those of academic institutions and State and local governments, to help develop scientific information useful for the establishment of such criteria, and for the measurement of effects of pollutants. I consider this a very useful thing that could greatly help us with our responsibility of setting criteria. I'm aware that the State of California has utilized private research laboratories for some of its activities. I don't know if they were for this specific purpose, but they were certainly for similar purposes. I feel that this kind of contractual relationship, either through a single Federal agency or through a variety of State and local agencies, would be quite possible and highly desirable.

GEORGE L. LEVIN *(Consulting Engineer, Levin and Bredrow, Inc., St. Paul, Minnesota):* My work is for the people in the grain and seed industry and has to do with the setting of standards in such a manner that the industry will apply its initiative to the problem of cleaning up the air. With regard to Mr. Stanley's City of Chicago ordinance, we found that it was not difficult to meet the requirement of .35 grain per cubic foot; rather, our problem was that the industry was not allowed to use its own initiative in achieving that standard. I can only suggest that it does not have to be a permanent standard; as long as it always has a specific value, it can always be changed. There is nothing wrong with saying .35 grain this year and five years hence changing it to .30. But there must be some goal toward which the industry can work, because industry basically, in order to be industry, is secretive and competitive. To put those characteristics to use, if we really wish to clean the air, we can let it use its competitiveness and its secretiveness toward that end.

I think that the Federal Government, therefore, should meet three requirements. The first is to set a precise number to indicate maximum permissible levels for each of the pollutants. The industry knows whether or not those pollutants are in the air. The facts are always available. The numbers can be changed, but they must always be precise. The second requirement is that pollutant levels should be measured exterior to the plant. Third, there must be no insistence that any particular device be used or barred from use. In other words, let the requirements be set on a numerical basis, change them as we progress, and let them be met by whatever means the polluter may choose to employ.

ROBERT C. ECKHARDT (*Member of Congress, 8th District, Houston, Texas*): There is sometimes an additional problem with respect to interstate commerce. It is an additional reason, it seems to me, for Federal control. Unless standards are somewhat uniform between States respecting industrial wastes there may be a lack of standardization in the cost of producing a certain product in various localities. This is very much the same situation that the Fair Labor Standards Act and other legislation applying generally to industry were designed to prevent. Further, it seems that there is always the question of competition, particularly from rural areas, which might invite industry on the basis of low levels of control. This situation, where a State government is concerned, may not reflect the desires and needs of industrial areas, but rather those of areas that are nonindustrial, and are not very likely ever to become industrial, but like to imagine that they will be. Would this in any way justify the use of the commerce power as, for instance, in the Fair Labor Standards Act?

ROSSANO: The point you raise is extremely important. I think industry appreciates the need for uniformity of standards throughout the country for economic competitive reasons. This can be accomplished through additional Federal powers and the wider invocation of existing Federal authority, or on the State level, with several States getting together and agreeing on standards they can live with. I think this points up what I was trying to say in my paper, that no matter how we approach the question of standards and criteria, in order to satisfy most of the people, it will take a very strong partnership between the Federal Government, on the one hand, and the State and local communities on the other hand, including every segment of the industrial community, and the private citizen, too. I don't have a final answer to your question. I think that will have to come from cooperation and dialogue between the Federal and the other levels of government, and the communities.

W. W. OWEN (*Executive Vice President, City Transit Company, Dayton, Ohio*): My question was prompted by the papers presented by Dr. Rossano and Dr. McKee. Why doesn't the Federal Government give more consideration to encouraging people to use buses or electric trolley buses instead of their private automobiles? Before I name the three things that I think should be brought to everybody's attention if anything is going to be accomplished by way of curbing air pollution, I want to stress that it's going to have to have the heavy hand of the Federal Government to get action on these three things.

The three things that should be done are these: (1) use a more comfortable bus, notably 102" wide instead of 96" wide; (2) encourage people to ride buses by giving preferential treatment to bus operations on surface streets by way of State statutes and city ordinances; and (3) encourage the retention of existing electric trolley buses, which are noiseless and fumeless.

As everyone now seems to agree, one of the greatest sources of air pollution on the streets is the automobile. I believe that we have to retain use of the automobile and I believe that we have to have balanced transportation, but I think we can limit the automobile to uses based more on necessity than on preference. I rode downtown on one of your buses in Washington last night. It was a 96″ bus and the aisle was 21½″ wide, and people had their feet in the aisle. When I went to get out, I had to push the door open; another gentleman helped me or I'd probably still be on the bus. Push-type doors are inconvenient and unattractive for passengers.

In Dayton, we have preferential traffic treatment for buses, that is, a plan to let the buses through. We got that far. We have no ordinance. At one time, we had an ordinance which provided that streetcars should have the right-of-way between cross streets. You can't expect people to ride public transportation and have fifteen automobiles pass them by in one block. To my way of thinking, it makes no sense to give the same traffic privilege to the average one-and-a-half occupants of an automobile that you would to 65 people on a bus. I think the 65 people crowded on a bus should have priority.

As for encouraging the retention of electric trolleys which are noiseless and fumeless, we have in Dayton 140 electric trolley buses and 40 diesels still in operation. There is a place for the diesel bus, too, but we have to admit that it does make fumes and it does make noise. The Federal Government has encouraged by loans and grants the conversion from electric trolley buses to diesel buses in many cities, and right now the issue is pending in San Francisco and Seattle.

Another thing that the Federal Government could do is to enforce regulations on the width of buses. In 1956, a provision was made in the Federal highway program that any State which did not then have provision for a 102″ bus could not widen its buses, and that applies to Rhode Island, Connecticut, and Hawaii. Incidentally, Hawaii allows the 108″ bus; in Ohio, we're limited to the 96″ bus. It was recommended that the Federal regulation be changed by the Bureau of Public Roads, and I hope that someone gets concerned with the subject and does change the regulation.

McKEE: Here, you are dealing with a strictly urban problem—urban air pollution. I think this is a matter that the States and communities must work out themselves. I think they would object to too much Federal interference in this matter. However, the Federal Government can assist, and I think it is assisting, through the mechanism of grants-in-aid for research on motor vehicle pollution and the setting of criteria, which I think are proper roles for the Federal Government.

COLONEL ALVIN F. MEYER, Jr. (*Chairman, Department of Defense Environmental Pollution Control Committee, Washington, D.C.*): This creates a dilemma which I think everybody interested in the problems of air pollution should be aware of. We have an effective partnership between the National Center for Air Pollution Control in the Department of Health, Education, and Welfare, and the Department of Defense and some of its subordinate sections, in the preparation of the five-year plan required by the President's Executive Order. The fact still remains that we have to comply with State and local requirements if there are any, as well as the Federal criteria and standards. Even when the States have issued no specific standards of their own, profound changes in our planning and budgeting will be required as a result of various actions taken or anticipated by the States.

It is rather characteristic of State and local authorities, who have not taken it upon themselves to issue their own criteria or standards, to make the Federal establishment the whipping boy. In other words, the smoke from the Post Office or from a Defense Department installation is apparently far more obnoxious to some people than the smoke from their own cities.

What I'm saying here is that there is a need for communication at the local level, a need for understanding of how the Federal Government goes about carrying out these new directives.

It is of even greater importance for everyone to understand that we, like some industries which are scattered all over the country, are faced with the need for allocation of resources on a priority basis. We can't fix up everything in the Department of Defense by 1967. Somebody has to make a decision on a national basis as to where the priority of effort must be directed.

And this again is going to require interchange and communication between the various levels of government so that there is indeed a full understanding of this, and so that unrealistic and unreasonable demands on the Federal establishment do not occur.

McKEE: Colonel Meyer, I have studied the provisions of the Executive Order, trying to evaluate it in terms of the program which the Texas Air Control Board will develop. At the moment, I don't see any cause for concern or any conflict.

Some of the provisions there are not applicable in areas such as ours where natural gas is burned as fuel, so I don't know what problems may arise in coal-burning areas, but as far as we're concerned I see little likelihood that the Texas Air Control Board, at least for many years, would ever adopt standards more strict than those that are already prescribed by the Secretary of HEW. Nor do I see much possibility that we are likely to adopt different standards that have not already been covered by the Secretary.

So therefore, I think that the primary effect of that Executive Order is to start Federal installations within the State of Texas along the road toward meeting what the State will later require of all installations. I don't see any great conflict or any undue expense in meeting these requirements.

A. E. BUFF, M.D. (*Executive Committee, West Virginia Citizens Air Pollution Council, Charleston*): All of us physicians have difficulty in writing, but we don't have any difficulties in histrionics and it seems to me that, at this meeting, there have sometimes been more histrionics than practical forward progress.

We in West Virginia have a particular problem and it is difficult, but so do the other States. What I want to say basically is that in air pollution there is one thing you must remember: it is people who are affected; people get lung disease; they get emphysema; they get cancer of the lung. The latter, I can't prove. The former, we can. If you are satisfied to spend the last ten years of your life slowly choking to death, don't worry about air pollution. Let's just worry about economics—and whether it is economically feasible to control the stacks and the pollution of the air.

I am very sorry there are not more M.D.'s, more practicing physicians, in the air pollution control program. I think they are sadly needed and, while engineers are needed too, there are many doctors who are also engineers. If you don't believe it, just think what is going on in computer medicine today. The present attempt by the several States to pursue a meaningful pollution abatement program is severely inhibited by the ever-present threat that such a program would drive industry out of the particular State involved. Most States either have ineffectual air pollution programs or none at all. In large measure, they yield to the irresistible economic pressures exerted by the huge interstate corporations. Inasmuch as the air knows no territorial boundaries, it follows that workable controls over the contamination of the air must be applied between the States as well as within the States. Regional compacts would appear to suffer from a lack of uniformity, territorial limitations, and other shortcomings which are different, but only in degree of severity, from those suffered by the respective States.

For these reasons, we, the Executive Committee of the West Virginia Citizens Air Pollution Control Program, feel that we should ask that the Federal Government enforce air pollution control, emission criteria, and air quality standards, allowing maximum feasible State and local participation. We further recommend that the appropriate Federal agency be authorized to conduct pilot control projects in various parts of the country and that enforcement procedures should include a permanent inspection system, criminal sanctions against violators, and a right of action for triple damages by those who are involved and who are pollution victims.

FREDRIC C. HAMBURG (*Principal Scientist, Booz-Allen Applied Research, Inc., Bethesda, Maryland*): We've heard this morning a wealth of information and advice with regard to air quality standards and criteria for planning, control, abatement, and the like, and I am sure that I join the overwhelming majority here in supporting the speakers in their conclusions and recommendations. But I want to inject a possibly discordant note in one specific area, and that is the problem of providing accurate, reliable, and timely measurements upon which criteria are based, and upon which further action is taken.

I suggest here that not enough stress has been given to testing the validity of our information. Are we truly observing the actual pollutant concentrations that we need to know for intelligent action? My own experience in this regard is that the degree of competence that I would like to have is sadly wanting.

I have seen data from two different sulfur dioxide sensors, for example—two sensors installed side by side, both properly calibrated according to their own specific but different principles of operation. The day-by-day measurements from these two will show practically zero correlation. Some days one is higher than the other, by as much as a factor of ten or more. On other days, the figures are reversed.

It seems to me that we must be sure that an indicated concentration of, say, 10 parts per million, is accurate to within at least 10 percent and that a different type of sensor does not show 100 parts per million or 1 part per million, which seems to be quite possible today.

I think that a proper role for the Federal Government here is to foster measures which will lead to a standardization of measurement techniques and instrumentation on a nationwide basis. Also involved here is the way instruments are exposed, including a standard height and standard atmospheric conditions.

Only in that way will we be confident that readings taken in, let us say, Chicago, can with validity be compared with those in Cincinnati or New York or Albany, and this, it seems to me, is one gap which must be overcome before we are properly forearmed and can properly judge how to plan ahead and determine what control and abatement measures must follow.

ROSSANO: Well, you have certainly presented an important problem in the technical area of air sampling and analysis, and I think those of us who have been in the field many years recognize that we do have certain limitations in our technology and our procedures. Of course, we're doing something about it, and I'm wondering if you're familiar with the fine work that is being done by at least two technical committees in this country.

One of them is a Committee of the Air Pollution Control Association, Committee TR-2 on Standardization of Methods of Sampling and Analysis. The other, which is likewise doing excellent work, is ASTM Committee D-22; this one has many subcommittees dealing with the problem of standardization of methods and nomenclature in air pollution. If you're not already familiar with them, I suggest you get in touch with them and join them, and perhaps you can help them.

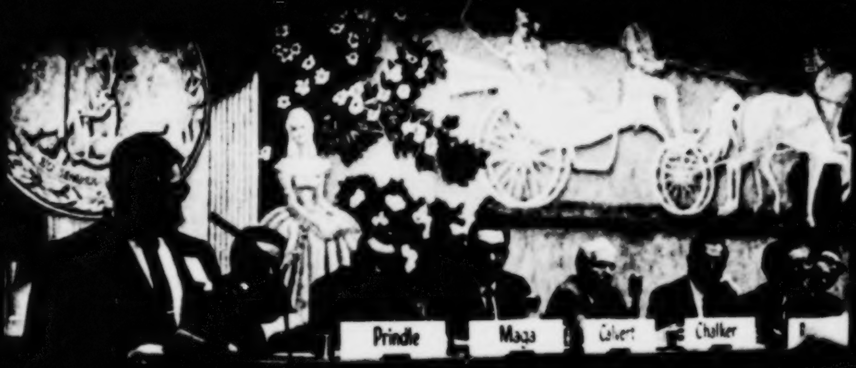
ARTHUR H. KLEIN (*Director of Environmental Health Services, Department of Public Health, New Rochelle, New York*): In local air pollution control agencies now establishing programs, we do not have the time to conduct research and thus repeat the errors of our pioneering predecessors. Likewise, the operators of pollution sources which we are regulating are not concerned with the difficulties of establishing rational emission standards. What they want to know is what they may send up the stack and still remain in the community. Until there is some further consensus or agreement on criteria or standards, either on a national or a local basis, how should local agencies apply regulatory measures?

Professor McKee has covered part of the answer, Dr. Rossano has recognized the demand for local action now, and Mr. Chalker has logically pointed out some of the things we should *not* do. All that remains now is for someone to tell us what we *should* do when we get back to work on Thursday.

ROSSANO: I'm not going to try to answer that question because I think that's what this conference should do. But I'm wondering if you are familiar with the fact that in New York State, you do have a Department of Air Pollution Control in Albany. It's an excellent one. And they've studied your area and many other sections of New York; perhaps you should go there first and try to work out the problem before going outside the State.

ARTHUR HOEKSTRA (*Director, Erie County Health Department, Buffalo, New York*): What level of government is best to provide proper enforcement? Some local judges are not qualified to judge technical aspects of air pollution and local politics thwarts justice in favor of vested interests. I think it should be enforced at a local level but there are problems at the local level, too.

ROSSANO: The prevailing philosophy is that the lowest level capable of dealing with the specific problem is the best.



G

December 13, 1966

PANEL G

ROLE OF THE FEDERAL GOVERNMENT IN AIR POLLUTION CONTROL

SECOND SESSION

Chairman William J. Stanley
Director, Department of
Air Pollution Control
City of Chicago

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". . . mechanical and industrial engineer . . . responsible for Chicago's air pollution controls, monitoring of air quality, and analysis of air pollutants . . . taught engineering at University of Illinois . . ."

INTRODUCTORY STATEMENT

WILLIAM J. STANLEY
Director of Air
Pollution Control
Chicago, Illinois

Welcome to the afternoon session of Panel G on the Role of the Federal Government in Air Pollution Control. We expect to hear many points of view on phases of government participation in air pollution control programs. A representative of the chemical industry and a representative of a national manufacturing association, will present industry considerations. A mayor of a large city; a governor of a populous State, and a Congressman with wide background in health problems and programs will present views of the Federal role from various levels of government.

It would perhaps be appropriate here to add some points of view of my own. I feel that:

1. National fuel use policy should take into account the air pollution problem existing in regional areas. The ability to use alternate fuels during stagnation periods and shift to emergency loads to adjacent power systems should be explored in detail.

2. Process cycle should be closed up as quickly as technology is available and special attention should be given "product cycles" whereby products are designed in such a way as to be dismantled economically when their useful life is ended.

3. The existing transportation problem of the United States, including expressways, should be evaluated in terms of air pollution potential within the next 20 years before reckless expansion is undertaken.

4. Urban renewal policy and cooperation on a demonstration city concept and other action programs in Federal cities should take into consideration the air pollution aspect.

5. The interrelation of air pollution water pollution, and land pollution should be documented and the change from one activity to the other should be evaluated on a long term basis.

6. A financing allowance should be made for small apartment owners desiring to convert to a more manageable fuel, for example., gas or oil.

7. The creative new management structure interrelating the problems of air, water, and land pollution should be designed to accelerate the programs in these various areas.

In many ways our discussions this afternoon are the key to future policy in air pollution control. I hope we may have a full discussion of the varying viewpoints to be expressed.

". . . researcher in rare earths, phosphates, nitrogen compounds . . . since 1949 with Monsanto as chemist, research director, manager of development . . ."

FEDERAL SUPPORT FOR INDUSTRIAL AIR POLLUTION CONTROL METHODS

We have heard a lot about the problems of air pollution, and we are all agreed that we do have problems. We do not need to be told too much more about the problems, but we do need to be told how we can solve them.

Air pollution is present and it is intensifying. Air pollution controls have almost—but not quite—kept up with industrial growth. Air pollution has not come upon us by surprise, like a specter in the dark. We have been collectively aware of it for many years.

Some of us have been working towards a solution of it for decades, and most of us can recall the smudgy cities of not too many years ago, when the air was heavy due to the use of coal- and wood-fired heating systems for residences; when big, bulky steam locomotives belched great clouds of black smoke; when uncontrolled smelters contributed their share to the pollution; and when smouldering, smoky city dumps spread a pall. We have but to recall these things to know that air pollution is no new problem.

Many people have assumed that air pollution, or smoke, is a necessary part of life, a necessary evil. Smoking chimneys often represented prosperity. During the depression, a salesman would stand on the highest spot in town, see where the chimneys were the blackest, and go there to peddle his wares. This, fortunately, is no longer true.

We know that air pollution is an evil, but not a necessary one. We also know that we have a multiplicity of new problems, those involved in the control of air pollution.

The United States owes its position today to its vast resources, its ingenious people, and its industry. America, through industry, has grown rapidly in many diversified fields, and this rapid growth has created many different and difficult problems. There is no single solution to air pollution problems, because our air is contaminated by many different types of pollution from many varied sources. Some pollutant problems are peculiar to a process. Some pollutant problems are peculiar to topography. Some pollutant problems are peculiar to a whole indusrty.

Because of the variety of the sources of pollutants, solutions are not going to be easy, but they are not going to be reached by setting criteria or by legislation.

Some air pollution is the result of a unique process practiced in a very few locations—for example, emissions of concentrated oxides of nitrogen from a TNT plant. Some air pollution is the result of a number of similar processes practiced at

JOSEPH G. STITES, Jr., Ph. D.
Enterprise Manager,
Air Pollution Control,
Monsanto Corporation
St. Louis, Missouri

many different sites—for example, phosphate fertilizer plants, metal or petroleum refineries, or power-generating stations burning fossil fuels. Some pollution is due to a large number of individual contributors operating in a concentrated area or an area of peculiar topography and climate—for example, the well-known air pollution problems of Los Angeles and London.

There is no single solution to the problem. A process developed to control emission from a petroleum refinery will not be applicable to the control of emissions from a blast furnace or a steel mill, or to an automobile exhaust, for that matter.

American industry, although certainly motivated by profits, has its responsibility, its requirements to perform, and its desire to be a good neighbor. Solutions to the air pollution problem will be reached through the same resources, the same ingenuity and creativity that have put our country where it is today. Additional research and development will be required, and the cost of conducting such research is escalating. Over the last 20 years, there has been a threefold increase in research costs. Today, to equip, maintain, and administer a research chemist or engineer, costs about $50,000 a year.

Research requires the use of sophisticated instruments—some of which we did not know about or which had not been invented 20 years ago. We routinely measure physical and chemical properties that we did not know existed 20 years ago. We have a much better understanding of the world around us now than we did 20 years ago, and we can visualize routes that may lead to the solution of many of our problems. To achieve this understanding and to test these routes will be time-consuming and expensive. How do we pay for this developmental work?

Many research projects are beyond the financial reach of the individuals, groups, or corporations which would like to carry them out. Scientific progress frequently is thwarted by the lack of funds.

The Federal Government, to remove these obstacles and to encourage research, has underwritten large programs and spends vast sums of money on research and development programs. The Government has set up many agencies for the purpose of financing, supervising and administering research programs.

Should industry seek Federal support for research on air pollution control or air pollution control methods? Before the decision is made, industry must be cognizant that there are pros and cons to be carefully weighed.

Governmental agencies cannot grant money for a research program without maintaining control over the project.

Industry should first decide whether it is willing to relinquish or assign this control.

The U.S. Public Health Service will be instrumental in setting air quality criteria and standards, particularly in interstate areas. It would be advantageous to have the Public Health Service an integral part of a research program leading to pollution control.

Federal agencies perform an excellent public relations function. A successful research program would result in favorable publicity.

It is possible to work simultaneously with several agencies, both inside and outside the Government, thereby taking advantage of the unique talents and moneys of each.

Larger sums of money would be available from Federal agencies than from many industrial sources. Many small corporations have air pollution problems or the desire to solve air pollution problems, but are stopped because of the lack of funds.

Federally supported research can be more fundamental. Historically, industrial research money has been impatient money. Impatience is not conducive to creativity. With more patient money, research can be carried out on a broader, more fundamental basis, and with a greater chance for creative solutions.

Since the Federal agencies which would grant the moneys would also review and administer the research programs periodically, an objective evaluation of the results, an evaluation not clouded by the profit motive, would be available from people acquainted with the broad overall air pollution control effort.

By working on a broader base of solutions and evaluations, the risk of failure would be minimized.

Also, by working with Federal funds, the danger of duplication of effort is also minimized.

On the other side of the ledger, industry should think before seeking Federal support for air pollution research. A prime factor to be considered by corporations seeking Federal assistance is time. Federal agencies, like all of us, operate on a budget. Budgets have to be prepared, reviewed, studied, and sometimes resubmitted, all of which takes time.

Before budgets can be submitted, the developmental programs have to be planned and reviewed, frequently rewritten and reapproved. A lead time of 18 months to 2 years is required for appropriations to clear the Government agencies.

Few individuals or agencies are willing to invest money in any venture without expecting to have a voice in the control of said ventures. Uncle Sam is no exception. If a Federal agency makes a grant, it has the obligation of supervising the plan of execution, the budget and the protocol of research.

The industry must decide to what extent it desires to relinquish control of the research project.

Federal agencies are representatives of the people of this country, and the money spent by these agencies comes out of the pocketbook of the public. The results obtained from the expenditure ordinarily become the property of the public insofar as national security permits. Before industry seeks Federal assistance, it must recognize that the results of research will be public unless a new arrangement can be worked out.

Industry must also be aware of the requirement of divulgence of know-how. Many industrial corporations today owe their existence to unique process know-how, obtained as the result of years of experience and expense.

Ordinarily the law prevents the unauthorized or unlicensed use of know-how. If the government-sponsored project requires revelation to the public of know-how generated by the industrial corporation participant, then this protection is lost. Additional protection usually lies in the patent laws, but these cannot help since the government requires the participant to assign new inventions and patents issuing thereon to the government for public use.

The result is that the industrial participant is left no way of protecting its inventions or its position.

As I understand the functioning of Federal agencies, proprietary information in the possession of a corporation prior to the granting of Federal funds can remain the property of the corporation; however, any improvements or further developments made as the result of spending Federal money become public property. Therefore, if Federal assistance is being sought to underwrite research for a commercial venture with the idea of developing a unique competitive position, then industry might as well forget it.

There are still many questions that must be answered. . . . What is a pollutant? Is it toxic or just a nuisance? How serious is the problem? What benefit will its solution be and whom will it benefit? How broad an influence will the solution have? Will the solution benefit a large geographical area, an entire industry, or a comparatively small group? How much money and work are required to solve the problem? What is the incentive in solving the problem? How can the problem be solved most economically?

And, perhaps another question that industry should ask is, "What is the fashionable approach?" We have but to study the Federal budget to realize that it is quite fashionable to solve problems with Federal funding.

Should industry seek Federal funds to solve its problem? I don't know. I'm a representative of the chemical industry; let's talk about it for a minute or two. We are not without our problems.

The chemical industry did not anticipate the pollution frenzy which is so apparent in the general press at this moment. Every industrial smokestack is suspect, and the chemical industry has not escaped its share of criticism. The answer to the problem is not legislation. The technical answer lies in chemistry and the practical answer lies in economics.

Industry has contributed to certain air pollution problems; therefore, it should be the responsibility of industry to solve its problems. If a company has a unique problem, then it should be the responsibility of that particular company to see to it that its problem is solved. If a problem encompasses an entire industry, then the problem should be solved through industry associations, as water pollution problems are solved by the manufacturers of surfactants.

In my opinion, Federal support for air pollution control devices or processes should be sought only after all private sources of funds have been exhausted. Federal funds should be used for the protection of the populace rather than for the benefit of industry.

However, the Federal Government, again in my opinion, does have a very important area of responsibility in air pollution control, and that is to assist in defining realistic air quality criteria. These criteria should be based on scientific fact and not on emotions or politics. They should be consistent with existing or developing technology.

Emotionally influenced legislation will not solve air pollution problems. Goals can be set and criteria established, but the technical answer lies in chemistry and engineering, and the practical answer lies in economics.

SUMMARY

Industry has the responsibility of solving its own problems. It cannot and is not closing its eyes to its responsibilities and it must make and is making its own decision to fulfill its responsibilities.

American industry, although motivated by profit and competition, also has a desire to be a good neighbor.

The Federal agencies can assist by defining realistic goals and schedules and by soliciting cooperation.

". . . former fire captain and sheriff . . . worked way through college as a fireman . . . Silver Star for heroism in W. W. II . . . mayor of Portland since 1957 . . ."

A LOCAL VIEW OF THE FEDERAL ROLE

TERRY D. SCHRUNK
Mayor
Portland, Oregon

I appreciate the opportunity to present a local view of the Federal role at this National Conference on Air Pollution. These remarks reflect not only my own experience with the problem of air pollution in Portland, but also the thoughts of many mayors of major cities throughout our country with whom I have discussed the matter. I have also had the benefit of staff advice from the U.S. Conference of Mayors Office in Washington, D.C.

The quality of our urban environment is one of the critical challenges facing our Nation. Historically, cities have been engaged in air pollution control for over 75 years, but prior to the mid-forties, these efforts were concerned only with smoke and dust control problems mostly in large midwest and eastern cities. The recognition of the serious effects of air pollution on urban living is a relatively recent development.

The primary causes have been well documented by comprehensive surveys in many urban communities. The main factors involve the population growth of metropolitan centers, the expansion of industrial production and power generation, the increasing numbers of motor vehicles and the rising quantity of refuse produced. Such growth and expansion place increased quantities and new types of air contaminants into our atmosphere.

The more familiar I become with controlling air pollution, the more apparent it is that a renewed dedication by Federal, State and local governments is mandatory to achieve desirable air quality. The challenge will be met only by a realistic division of labor concerning the responsibilities between the Federal, State and local governments.

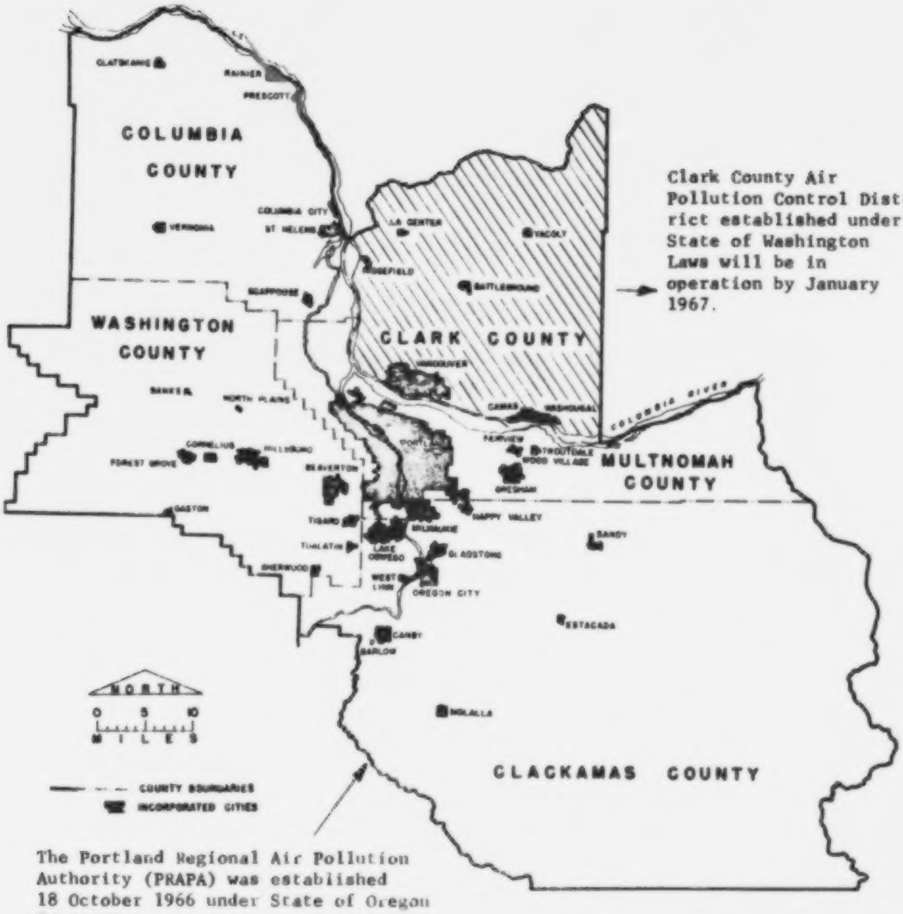
The Federal role is primarily that of a prime mover in sponsoring the broad and expensive research and development required to identify our air quality goals that will protect human health, reduce property damage of all kinds, and restore the desirable attributes of a clean, safe urban air supply.

The role of local and regional community government is, as the action agency, primarily to control and prevent air pollution throughout the community.

The primary role of the State government is to serve as a back-up agency for the community control effort in adopting standards applicable to the regions within the State, in providing specialized assistance to local and regional programs, in negotiating with adjacent States, and in sponsoring research in unique problems.

EXPERIENCE IN PORTLAND

The City of Portland air pollution program was very limited until 1964, when a


CLATSKANIE
RAINIER
PRESCOTT
COLUMBIA COUNTY
COLUMBIA CITY
ST HELENS
VERNONIA
SCAPPOOSE
LA CENTER
YACOLT
RIDGEFIELD
BATTLEGROUND
CLARK COUNTY
VANCOUVER
CAMAS
WASHOUGAL
COLUMBIA RIVER
WASHINGTON COUNTY
BANKS
NORTH PLAINS
CORNELIUS
HILLSBORO
FOREST GROVE
BEAVERTON
PORTL
FAIRVIEW
TROUTDALE
WOOD VILLAGE
GRESHAM
MULTNOMAH COUNTY
GASTON
TIGARD
MILWAUKIE
HAPPY VALLEY
SANDY
TUALATIN
LAKE OSWEGO
GLADSTONE
SHERWOOD
WEST LINN
OREGON CITY
ESTACADA
CANBY
BARLOW
MOLALLA
CLACKAMAS COUNTY
NORTH
0 5 10
MILES
COUNTY BOUNDARIES
INCORPORATED CITIES

Clark County Air Pollution Control District established under State of Washington Laws will be in operation by January 1967.

The Portland Regional Air Pollution Authority (PRAPA) was established 18 October 1966 under State of Oregon Statutes.

FIGURE 1

new air quality control code was adopted by the City Council. The city, in drafting the new code, called for assistance from representatives of industry and the Oregon Sanitary Authority. The drafting took approximately a year to complete, but I feel that we now have one of the best air quality control codes in the country.

Since 1964, with the aid of a Federal grant, Portland has launched a full-scale program which has produced significant control actions, resulting in the installation of several millions of dollars worth of air cleaning systems, and other processes.

However, the area-wide problem still existed, affecting the air quality in the central city. Portland realized that unless there was a coordinated program of air pollution control on a metropolitan basis, local accomplishments would be limited. Thus, from the beginning, we strongly urged the surrounding counties and cities to join with us in control efforts. Finally, in the Spring of 1966, through the cooperation of the U.S. Public Health Service, the Portland Metropolitan Study Commission, the Oregon State Sanitary Authority, and the City of Portland, a regional control program was formed, involving the cities of Clackamas, Columbia, Multnomah, and Washington County with the City of Portland (Fig. 1).

The northern boundary of the region, is the Columbia River which is also the boundary between Oregon and Washington. A population of 835,000 resides in this 3700 square mile area.

Clark County, across the Columbia River in Washington, has now formed an air pollution control district under the State of Washington to serve a population of approximately 110,000 people.

A comprehensive prevention and control program is being organized to serve this region. A Federal grant application for $150,000 has been submitted which will support a program at a rate of $200,000 per year. This will about double the existing city program, staff, laboratory and sampling equipment. This progress is made possible because of the Federal grant funds. I am confident that the regional effort will succeed in greatly improving the air quality and providing better management of our air resources.

It is encouraging to see Clark County, Washington proceeding with the formation of a county control district, since we share the airshed with them.

It is evident, however, that active participation by the States of Oregon and Washington is required to achieve a coordinated program. Neither State now has the staff or facilities to meet this need. Important new action is required by both States and by the Federal Government if the Portland Regional Air Pollution Authority is to achieve its goals in a reasonable period of time.

There are several sources of air pollution in the region that require a Federal response.

The region is seriously affected by the slash burning in the federally-owned national forests, along with State and private lands, the open burning of agricultural wastes, and air pollution from the kraft pulp-making industry. In the region, there are five pulp mills that are producing excessive air pollution.

The costs for such controls will no doubt be substantial, but I am confident that an organized research and development effort will produce control alternatives that will be reasonable and effective.

In the Portland Regional Air Pollution Authority region, refuse disposal needs improvement. In Portland, elimination of open burning has reduced air pollution. However, serious problems exist in the proper disposition of tires, oil, auto bodies and wood residuals. Some important breakthroughs have been made in connection with these problems. For example, I understand that now a new process breaks up old cars into small pieces, so that steel can be extracted magnetically, to produce 90% pure scrap. Certainly, this should mean an end to most of our automotive scrapyards.

Many of these problems are of national scope and require the attention of the Federal Government. It is obvious that a lot more work has to be done, especially in research in waste disposal. Cities do not have the resources to do this research. Therefore, I think it is mandatory that the Federal Government and private research grants tackle these problems to give State and local governments the benefit of their findings and recommendations. I am sure that we will carry through with the rest of the job.

Increased funds have expanded the technical assistance, training and informational services of the Federal program. The new abatement branch has recruited a staff and has held hearings on several interstate air pollution problems. These major program additions have occurred in a relatively short time, largely as a result of the rising tide of public concern about the quality of its air supply.

In my discussion with the mayors of other cities about the Federal role in air pollution, I found no serious criticism of the Federal program activities or their administration. However, in these discussions, a number of general problems were identified, such as:

1. The inability of most States to provide the leadership to the urban areas within the States.
2. The critical shortage of technical manpower to staff the community programs.
3. The lack of local and State public informational programs.
4. The difficulties in preventing new air pollution problems through coordination with local planning and zoning actions.

5. The failure of certain classes of industries to develop adequate solutions for unique air pollution problems, and concurrently, their failure to organize appropriate research and development that would offer a probability of solutions within a reasonable period of time.

It is obvious that the Federal Government's role in the effort to achieve desirable air quality must expand. It is imperative that means be applied to require State government to assume its responsibilities in the air pollution prevention and control field. If this is not substantailly improved soon, it is inevitable that the urban governments and the Federal Government will be forced to fill this void. This development will, in the long run, be undesirable and should be avoided except as a last resort.

There are several alternatives that may stimulate additional State activities:

1. Assignment of staff from the Public Health Service to assist the States in developing appropriate revisions of state programs.
2. When the response from the State is inadequate, public conferences should be scheduled to consider potential air pollution and transmit the findings to the persons responsible as well as to control agencies.
3. Strengthening Public Health Service regional offices with additional manpower so that a planned program can promote State action, such as:
   a. Control of Federal sources of air pollution within the State.
   b. Release of news stories about air quality improvement in other States.
   c. Popularization of the advantages of a healthful community air supply.
   d. Activity by citizen study and action groups concerned with effective state government.
   e. Circulation of data from the national air sampling network stations and the air pollution effects network to Governors and State Boards of Health to inform them about poor air quality conditions and the probability of adverse effect upon the public welfare.
   f. Activities by community and State air quality control representatives to develop increased effectiveness.
   g. Improved programs to develop air resource management. If primary needs are not being met in a reasonable period of time, suspend grant payments until appropriate changes are made.

COOPERATION AMONG AGENCIES

In its future role, the U.S. Public Health Service should encourage coordination with the Department of Housing and Urban Development in programs such as urban renewal and demonstration cities.

Most community and regional agencies are trying to overcome deficiencies in the data describing their local meteorology. The Department of Commerce Environmental Sciences Service Administration which handles weather forecasting services might respond to this recognized need. This Department should extend its function to collect and evaluate the basic data needed by community air quality control agencies, and thus avoid very expensive duplication of effort.

The development of economic incentives for control, particularly for industrial processes, needs further study and development. Some method of tax benefit or penalty may be effective in promoting solutions to new processes and existing operations.

COMMUNITY AIR STANDARDS

All programs serving local, regional and State control agencies need more regulations defining desirable air quality. These formal goals or objectives will permit the regulatory agency to clarify the degree of control required by industrial, commercial, transportation and public sources of air pollution. Source control regulations should be promulgated consistent with the regional facts including the growth in population and industry.

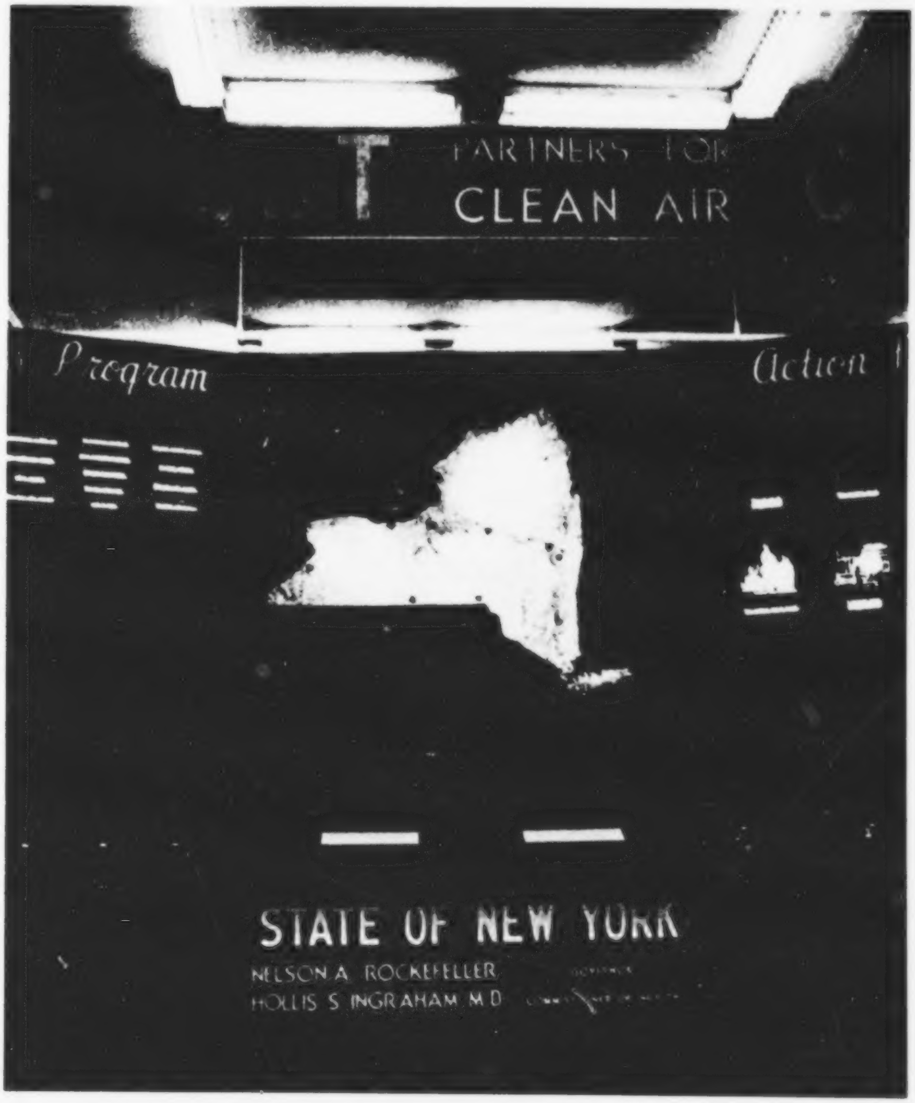
In 1956, Oregon adopted community air standards for particulate fallout rate, suspended matter, and similar contaminants.

In 1959, California adopted more comprehensive air quality standards. These pioneering efforts have helped, but great problems remain.

The 1963 Clean Air Act directed the Secretary of Health, Education, and Welfare to publish criteria of air quality based upon the latest scientific information. These publications will enable State and community air pollution agencies to formulate source limits and surrounding air standards. I cannot overemphasize the critical need for these new regulations. Whatever can be done to expedite these publications should be done.

CONCLUSION

I have outlined the major expansions needed in the Federal role to assist the local agencies in performing their responsibilities. I am convinced that a realistic teamwork approach must be strengthened in the years ahead to deliver desirable air quality. The public demands improvement. The resources of our country are equal to this demand. We must control now for clean air. There really is no acceptable alternative.



A STATE VIEW OF THE FEDERAL ROLE

OTTO KERNER
Governor of Illinois
Springfield, Illinois

In all of our States, the basic legal and moral responsibility for the protection of our environment rests with the States. People look to their State agencies for the assurance that their environment is and will be protected against hazards and potential hazards.

These State activities sometimes are initiated at the urging of local governments, sometimes initiated by the States and sometimes inspired by a Federal activity or Federal policies. Often the uncertainty concerning the ultimate dimensions of a particular problem or activity and the relative positions of the Federal and State governments in respect to Federal regulations will preclude extensive State legislation. This is often true because of the uncertainty, and sometimes, of course, because of the lack of technical competencies or personnel.

I would like to discuss briefly some of the practical experiences that the State of Illinois has had with Federal air pollution control and allied activities. Obviously, I know most about my own State and its problems, but more important is the fact that our experiences are typical ones which might be and often are encountered in other States.

While there has always been a consciousness of air pollution problems in Illinois—particularly in the metropolitan areas—only recently have we begun active abatement and prevention programs. We have initiated aggressive research, study and abatement programs in these areas. In the course of this activity, we have learned a great deal about the possibilities, as well as the limitations in the field of domestic and industrial air pollution control.

Our public has also become generally aware of the public health hazards and economic losses that can be caused by air pollution and has shown increasing interest in the measures for prevention, abatement and control. This, in turn, has enabled us to secure bipartisan sponsorship and passage of implementing legislation.

While many of our air pollution problems are relatively old in terms of years, our authority for control and abatement at both the State and the local level is relatively new. We like to think that the effectiveness of our efforts in this area has been a reflection of our administrative attitude.

The Illinois General Assembly in 1961 passed an act to allow local governments to find solutions for pollution problems. The bills authorized counties to adopt ordinances for the purpose of lessening or preventing the discharge of air contaminants. A similar measure granted regulative authority to cities, villages, and incorporated towns, and a third bill created a Northeastern Illinois Metropolitan Air Pollution Control Board with its administrative home in the State Department of Public Health.

At the same session, an act was passed to create a State Air Pollution Control Board in the Department of Public Health. The bill, however, only made provisions for investigation and voluntary cooperation and provided no authority to control the conditions where pollution was found.

The problems of air pollution had already been explored at length by the Illinois Department of Public Health under its authority to make examinations and tests for the evaluation of health hazards, but the Department lacked the power to prevent or abate pollution of atmosphere where it was found.

Since the bill to create the board did nothing to remedy these critical deficiencies or to allow for an effective State air pollution control program, I vetoed the legislation.

At the next session of the General Assembly in 1963, I asked for stronger legislation, pointing out that the problems of air pollution in our metropolitan areas are often beyond the capacity of the individual jurisdiction since air pollution knows no municipal boundaries.

In some cases it has become a nuisance and menace even in our small communities—communities that often lack technically trained staff to cope with the problems.

I recommended that the Department of Public Health, in consultation with industry, labor, municipalities, the medical profession and the Federal Government, develop recommendations for effective State legislation to abate and control air pollution.

With the active cooperation of all these groups, this recommendation was carried out. The bill was part of the administration's legislative program. It received bipartisan sponsorship, endorsement and support. It was passed and signed into law in the summer of 1963.

The legislation created the Illinois Air Pollution Control Board as a separate agency whose sole jurisdiction is in the field of prevention, abatement and control of atmospheric pollution. Represented on this Board are public health, medical, industrial, labor, professional engineering groups and the public at large. Of particular importance is the provision that the Board is authorized to negotiate with proper agencies in adjoining states to effect interstate compacts. This, briefly, is our history in the field of air pollution.

Even before Illinois had an air pollution control act, the role of the Federal Government within the State was recognized. This recognition was and is translated into practical working relationships. From 1957 to 1959, for instance, the Illinois Department of Public Health joined with the Indiana State Board of Health, and the United States Public Health Service, in conducting a bi-state study of air pollution in the Chicago metropolitan area, covering five counties in Illinois and Lake County, Indiana. It early provided a compilation of information relative to air pollution in that area. In addition, the study produced some preliminary estimates of the emission of several types of air pollutants to the atmosphere. It served and still serves as tangible evidence of the working relationship on a common problem between the States of Illinois and Indiana and the United States Public Health Service. It should serve as an excellent example of the actual working relationship that can exist between Federal agencies and the States.

The Illinois Department of Public Health actively supports the technical assistance agreement projects in Chicago and in Cook County, similar cooperative ventures with the Public Health Service. To assist the Cook County Department of Air Pollution in its initial effort, the Department provided certain laboratory services and technical assistance.

The cooperation with the Public Health Service has not been limited to the Chicago area. An interstate air pollution study in the East St. Louis-St. Louis metropolitan area was conducted by the State agencies of Missouri and Illinois and local agencies in both States, with the active assistance and cooperation of the Public Health Service. Illinois participated in this project through membership on an executive committee that guided the study by providing essential liaison activities and the laboratory services which are essential in this type of activity.

The Illinois Department of Public Health joined with the Chicago Department of Air Pollution Control and the Northeastern Illinois Metropolitan Area Planning Commission in undertaking an air resource management study for Northeastern Illinois. It is my understanding that this will be one of the first efforts in the United States in the planning of air resource management through a Federal grant. It likewise represents an extension of surveillance activities into the area of regional planning.

A less generally recognized type of cooperation, but one that offers great potential for the future, is the enactment of interstate compacts. Illinois and Indiana, in 1965, became the first States to effect this type of cooperation by negotiating a compact that provides for an interstate agency with authority to control air pollution originating in one State and affecting the other. This agreement, which is now before Congress for ratification, will apply particularly to southeastern Cook County in Illinois and the Lake County area in the State of Indiana.

These are just some of the examples of joint State-Federal activity.

From the standpoint of public health, there is a striking similarity between water resource management and air resource management in both need and problems; both are resources vital to our public health and our economic health. Air, like water, is a commodity that must be used and reused.

I believe that the management of our air resources, particularly to maintain quality fit for human consumption, is a concept new to some, but to many of us it is merely the common-sense application of known principles of management.

I sometimes feel that the demands of the public for cleaner air are ahead of the technical and financial resources of the States and the Federal Government in providing practical answers to the complex technical problems that are involved. This particularly relates to problems of industrial air pollution control.

There is a recognized need for exploration of many of the blank spots on the air quality control "map." This not only involves, but requires, a mutual appreciation by the public, the industrialist, air pollution control technicians, and elected officials. All must adopt the habit of working together, knowing intellectual habits and recognizing various viewpoints. Such cooperation is not a mere expression of sentiment, but is a national economic necessity.

Today we can merely hope that neither a single substance nor the combination of substances resulting from their mixing in the air is toxic to human or animal life. Analytical methods and standards of measurements cannot determine the quantitative presence of all the substances emitted into the air. This is particularly true of industrial emissions. We need up-to-date parameters for evaluating the quality of air.

This might raise a question: Where does the responsibility lie for determining whether the products of our modern industrial development are toxic as discharged into the air? This answer does not involve solely technical considerations. It is the responsibility of Government—State or Federal—to prove industry guilty. Is it industry's responsibility to the public to predetermine and furnish adequate proof to the quality control agency? Without up-to-date parameters and laboratory methods, both Government and industry have difficulty in discharging their responsibilities.

Given this framework, let us strike at the heart of the question before us. What is the State view of the Federal role in air pollution.

There is no question that the principal role of the Federal Government (specifically the Public Health Service) at the present time is that of providing financial assistance and technical aid, through research, equipment, personnel and training, to aid with those special problems which fall beyond the resources of the various States.

Another—and an extremely important role—is the enforcement of air pollution laws where interstate pollution is involved. There is a place here, I believe, for the Federal Government, but there is also a danger—that such Federal actions could overstep the clearly defined patterns and policies followed by the Federal Government in all areas.

For instance, in Illinois, the Air Pollution Control Board never takes action unless it is satisfied that local remedies are exhausted and that local authorities are unable, unwilling, or incapable of taking necessary steps to alleviate air pollution. Similarly, our proposed interstate compact with Indiana assures that the efforts of local and State air pollution control agencies will be exhausted before the interstate authority becomes effective.

The Federal Government must make sure that the States are unable or unwilling to cope with the problem of pollution abatement and control in interstate pollution. Unfortunately, there have been situations where it appears that a Federal agency has taken action and later come up with the justifications, rather than obtaining an impartial evaluation of the facts and then making the decision.

Some machinery should be set up whereby there could be a mutual evaluation by the States and the Federal Government of an interstate problem prior to the intervention of a Federal agency. From the viewpoint of a State, it would appear that the Federal Government should encourage the formation of interstate compacts. But, so far as Illinois is concerned, there has been no such encouragement by the Federal agency charged with air pollution control. We have been trying to get our compact with Indiana passed for the better part of a year. I hope it will be passed this year in the Congress.

The following are some of the ingredients necessary to a successful State-Federal relationship in air pollution:

1. A State administration cannot and must not avoid assuming a direct responsibility in the field of air pollution control. It is felt that any abdication of a State's responsibility could not be made without jeopardizing the health, well-being, and the economic life of the citizens of that State.

2. There should be no reluctance on the part of a State air pollution control agency to accept its administrative and technical responsibility for the protection of air and environment. This must be accomplished in spite of the esoteric nature of this activity and the semantic problem often injected.

3. The responsible State agency must make a deliberate attempt to foster good relations, without compromising its responsibilities, so that the State and Federal agencies involved will be working toward the same target objective. Obviously, such an attempt should also be made by the Federal agencies.

4. There must be a mutual appreciation, both technically and administratively, of mutual objectives, problems and responsibilities.

5. Both State and Federal Governments must accept the realization that there must be a practical and realistic approach and a commonsense attitude, particularly in the problems of industrial air pollution control. We do not wish to see vital industries pushed to the brink of extinction.

Our State has not and does not intend to abdicate its responsibilities in this important field of air pollution control. At the same time, it realizes there remains much to be done in an activity so vital to the public health, economic health and the welfare of the people of our State. It will require the close cooperation of the State, the local communities, our neighboring States and the Federal Government.

I hope that the spirit of my contribution to this session has emphasized a confident reaffirmation that a State can be sufficiently interested, active, alert and resourceful, to realize and discharge its duties in the pollution control phase of protecting our air resources.

I believe the States can and will pursue a broad, sound, economical and practical approach to solving the problems of air pollution, and through the medium of interstate compacts and agreements they will discharge their duties and obligations to each other while at the same time preserving the integrity and strength of their own intrastate programs.

". . . chemical engineer . . . with Mallinckrodt since 1939 as researcher, project manager, vice president and president . . . on the board of a score of companies and organizations, including National Association of Manufacturers. . . ."

AN INDUSTRIAL VIEW OF THE FEDERAL ROLE

HAROLD E. THAYER
Chairman of the Board,
Mallinckrodt Chemical
Company; Chairman,
Area Industrial
Problems Committee, NAM
St. Louis, Missouri

No one person can express the "industrial view." The diversity of viewpoints within American industry is wide-ranging. However, I have had the opportunity to become acquainted with the thoughts of many company officials representing different industries, different sizes of companies, and different parts of the country. I feel that my remarks will reflect some degree of industrial consensus on the subject of air pollution.

It would appear beyond question that the reduction of pollutants in our air and maintenance of air at healthy levels are extremely important and monumental tasks. Hanks and Kube, in the *Harvard Business Review*, have estimated that $105 billion, an average of $3 billion per year, will be spent between now and the end of the century on air pollution abatement and control. Just to put this into perspective, the atom bomb was developed for less than $2 billion in a four-year period, and we are spending some $5 billion per year on our space program. You can easily see that the problems surrounding air pollution represent an enormous program by any standards.

Air pollution, as we all know, is very serious in hundreds of communities. There are at least as many possible sources of pollution as there are residential chimneys, industrial smokestacks, and automobile exhaust pipes.

It seems clear that the problem is shared by many groups of people and all political jurisdictions. Not only is the problem big, but there is also a mounting feeling of urgency to abate pollution now, if not yesterday.

Considering the magnitude, the diffusion, and the urgency, it seems an understatement to say that the cooperative efforts of municipalities, States, the agencies of the Federal Government, the householder, the auto owner and industry—all of us—will be required to get the job done on time. By "on time," I mean before public impatience results in dumping the entire problem in the Federal lap.

In a task of this magnitude, certainly there are jobs for each group that each can perform best. Rather than talk only about what role the Federal Government should play, I prefer to include some tasks of industry as well. What I propose to present is, in a sense, two job descriptions, one for the Federal Government and one for industry. Then I will have some observations on Federal action and industry action that I believe will improve the chances of success in the fight against air pollution.

THE FEDERAL ROLE

The Clean Air Act and its amendments have established the role of the executive branch of the Federal Government. Additional legislation affecting air pollution abatement, granting broader powers to the Secretary of Health, Education, and Welfare is likely to be proposed. It would seem that both Houses of Congress feel strongly called upon to end air pollution quickly, and are ready to propose almost any and all reasonable and conceivable control actions.

Unfortunately, the Congress cannot make new inventions as they can make new laws, and it is new inventions and processes that will be necessary to cure some of our worst pollution in an economic manner.

To my mind, Congress, having enacted good legislation regarding air pollution, now should give it time to work. I feel that Congress should keep a close watch over the operations of these statutes to determine whether or not Congressional intent is being honored, and to make legislative correction only if needed.

"Pollution" evokes strong emotional responses in all of us. Strong groundswells of indignation, strong calls for action, and strong clamor for the heads of public officials deemed to be ineffective may tempt the legislative branch to ever greater concentrations of regulatory and police power. We of industry hope that the legislative branch exercises restraint in the grant of police power. Certainly the need should be clearly evident before any greater powers are granted.

In this connection, it may be appropriate to distinguish between the creation of air pollution and the problems of abating and controlling it.

Pollution of the air may give rise to sociological, physiological, political, and other disturbances. Abating air pollution, however, is a technological problem, a matter for scientists and engineers. It seems important that all of us realize this and that our legislators keep in mind that much technology must be developed before pollution is controlled.

I believe that we have good laws that will work. The control of air pollution will be achieved about as fast as we develop the corresponding technology. The Congress might now give the prescription a chance to work, making sure that the scientific and engineering activities of the Federal agencies, such as the National Center for Air Pollution Control of the Public Health Service, are adequately funded for the future.

The role of the executive branch of the Federal Government is mainly the responsibility of the Department of Health, Education, and Welfare. As defined by law, the executive has four broad functions:

1. To give leadership, assisting and encouraging municipalities and States to take action toward abatement and control.
2. To establish a national research and development program for prevention and control of air pollution.
3. To establish criteria, defining what levels of pollutants are harmful, to publish them, and to make recommendations for their adoption.
4. To secure abatement of air pollution under clearly defined legal procedures where State or other local efforts fail.

If one examines the detailed functions set out in the statutes, it appears that the Congress has placed on the executive the responsibility of leading rather than driving the States and communities to abate and control air pollution. Its role is somewhat inspirational, and I believe it is already effectively inspiring many communities to action.

The research and development role is of key importance, as are the dissemination of information and the establishing of criteria. With the addition of abatement activities, the Federal role constitutes a remarkably comprehensive program. It is significant to note the great extent to which the program involves group interrelationships—interrelationships of the Department of Health, Education, and Welfare with other Federal departments and agencies, with local, State and interstate air pollution control agencies, and with industries. Reading the laws, one is struck with the frequency of the words "cooperate," "cooperation," "encourage," and "cooperative."

We in industry believe that this is as it should be, and that Congress was wise in writing the Clean Air Act in this fashion. Air pollution being a sociological problem, effective action toward solutions in this field must depend on constructive group motivations.

This presents a challenge of the greatest magnitude for the Department of Health, Education, and Welfare, so to exercise its power and authority as to provide cooperative action. Such inspiration must in turn be radiated by local leadership in the various communities and regions. An inspirational role is not the easiest in the world. However, it is of the utmost necessity and importance.

Obviously, by the nature of things, the Federal Government cannot directly carry out a day-to-day air pollution control program at the local level. But it must secure the support of a team which can.

As the National Association of Manufacturers pointed out in testimony presented before the Subcommittee on Air and Water Pollution of the Senate Public Works Committee in September, 1963, "effective air pollution control is a job which requires constant policing of thousands of boilers; home heating units; backyard trash fires; apartment, hotel and office building furnaces; and many other sources—a task for which the Federal Government is singularly ill-suited and for which local government is singularly well-suited."

Thus, it is entirely appropriate that the major emphasis in the Federal role should be on other aspects of the total problem, such as basic research, collection of data, dissemination of information and technical assistance in addition to the inspirational role to which I have referred. All of the Federal responsibilities add up to a heavy assignment, and one which, if not performed successfully, will result in failure of the total program.

INDUSTRY'S ROLE

Bearing in mind that air pollution at some levels is dangerous to public health, and that public demand for abatement can be expected to rise, industry should take definite and major steps to continue an accelerated effort to control its own pollution. Industry has been working on the control of air pollution for many years, and much progress has been made. About a year ago, Herbert Lund, editor of *Factory Magazine*, estimated that industry was spending $700 million per year for control equipment, surveys and research, and expenditures are continually increasing.

Bearing in mind that the engineering, design, fabrication and erection of abatement facilities constitute a time-consuming process, perhaps as much as two or three years in the case of new processes, industrial companies that do not have pollution control programs should begin now to plan for installations that may not be necessary today, but are likely to be required as air quality standards are adopted. All polluters—and that means just about all of us—should be looking ahead and preparing to abate pollution. The manufacturing industries are estimated to account for less than 20 percent of our air pollution. Home furnaces and automobiles account for far more.

Engineering, economic analysis and construction plans can be started and made a part of corporate long-range plans. Corporations might also begin to consider the effect of the investment in abatement facilities on the costs of doing business and their effect on product prices.

Since air pollution is a local or regional problem, it seems wise for representatives of industry to participate actively in municipal or other local pollution control groups. Industry people are, in many cases, highly conscious of the technical nature of pollution control, and their presence in local groups may lead to wider understanding of this important factor.

Industry needs to be familiar with the Federal programs of research, development, field assistance, and abatement, and to offer the Federal agencies cooperation. Many corporations are doing this, and their number is growing.

One of the functions industry can best perform is to testify in public hearings, bringing a calm, fact-based viewpoint to bear on what may otherwise tend to become an emotional diatribe.

Finally, American industry automatically has the function of developing the hardware and perhaps some of the processes that will be needed to control air pollution. The design, engineering, fabrication and installation of devices obviously must be carried out by industry.

ACTIONS AND ATTITUDES

I hope industry will not yield to the temptation to regard Federal agencies as adversaries trying to persecute us. I hope that the Federal agencies will not decide that they need a whipping boy and jump on industry. I am confident that industry and the Government are not now in separate camps.

I believe that it is generally appreciated that we are all both polluters and "pollutees." This is a situation for which every citizen bears a share of blame, from which every citizen suffers, and one which requires the best efforts of all of us to solve.

Almost everyone agrees that our air must be clean, and that the time for action is now. What will be needed is the kind of industry-government cooperation that we have always enjoyed in the face of national emergency, the kind that gave us atomic energy and our great achievements in space.

The cause of pollution control would be greatly advanced, in my opinion, if the people of this country understood that some aspects of the problem may take years to solve. Take the case of sulfur dioxide in the atmosphere, for example. Today our only reasonable control measure is to burn low sulfur fuel, which is scarce. But research by the National Center for Air Pollution Control of the United States Public Health Service is seeking to find ways to economically remove SO_2 from stack gases. Several years of development may be necessary before the engineers of the Public Health Service will be able to demonstrate a prototype plant, and additional years may be necessary to apply this knowledge to a larger, coalfired electric powerplant.

Even if the technology were adequate and the engineering and construction could be accomplished quickly, there is one more variable in the equation that deserves attention. This variable is incentive. Generally and unfortunately, there is no natural economic incentive to installing air pollution abatement and control facilities in existing plants. Productivity is not increased, costs of manufacturing are usually raised and seldom lowered. How then can corporations be encouraged to take more voluntary steps?

We suggest that this is an aspect of the air pollution problem that deserves much more thought and study than has been devoted to it up to now. We of the National Association of Manufacturers have taken the stand that there should be some recognition that the investment in control facilities, while having social benefits, does not contribute to profits.

Such recognition, we say, might well take the form of accelerated amortization of facilities or investment tax credit. Speaking for myself, I feel that this aspect of pollution control could profit by joint industry-Federal study. Of course, all aspects of the broad pollution abatement problem would profit from this team approach.

I would like to take this occasion to propose a step that may make a concrete contribution toward achieving a joint Federal-industry cooperation. I suggest that a group of top-level industry officials from the broadly representative committee with which I am associated might meet from time to time on an unofficial basis with officials of the Department of Health, Education, and Welfare, the Public Health Service, the National Center for Air Pollution Control. The exchange of views in such a group should result in mutual understanding and tolerance and friendly cooperation that will lead to the development of an increasingly sound program.

I appreciate having had this opportunity to express an industrial view. The exchange of views in this Conference spotlights many areas of agreement and disagreement between government officials and the public, in which I include business and industry. I hope that this Conference results in a great enlargement in the areas of agreement and a great contraction of the points in which there is disagreement. I hope that this Conference results in a fusing together of an effective team of all those agencies, institutions, groups, and jurisdictions whose efforts will be necessary to abate and control air pollution. I hope it generates mutual tolerance and understanding. If the Conference accomplishes these results, this great problem will be successfully solved.

". . . member of Congress since 1955 . . . lawyer . . . recipient of many distinguished service awards for conservation, preservation and wise use of land, air and water. . . ."

A CONGRESSIONAL VIEW OF THE FEDERAL ROLE IN AIR POLLUTION CONTROL

JOHN D. DINGELL
U.S. Representative,
16th District
Michigan

The problems we are discussing today might most aptly be considered in the light of a story I have heard about a certain farmer who was visited by the county agent. The county agent approached him and said, "Zeke, I'm here to tell you how to farm better."

Zeke shifted his chewing tobacco from one side of his face to the other, looked the county agent right in the eye, and said, "Well, that's just great. I certainly do appreciate that. But if it's all the same to you, I would just as soon that you don't bother, because I'm not farming as well now as I know how."

Air pollution, I think, is the largest single remaining problem upon which no really meaningful major attack has yet been mounted in this country. I took the trouble to look up some of the figures dealing with questions like the amount of economic and health loss inflicted upon the people of this country by air pollution. I find that the economic loss alone is conservatively estimated at being more than $10 billion a year, whereas our combined State and local expenditures to control it have been catalogued as being on the order of $20 million a year, with a corresponding amount from the Federal Government.

Air pollution is a major contributory agent to every phase of health damage, to most of the different forms of bronchial and respiratory ailments with which people in our country are afflicted, including emphysema and lung cancer.

It is fair also to say that air pollution is a major contributory agent to crop damage, to industrial losses, and to destruction of homes and neighborhoods.

I would join anyone in the statement that air pollution should not be entirely a Federal responsibility. It is very clear that the Federal Government is not set up to check every smokestack and automobile exhaust in this country. It would not be consistent with our form of government or our economic philosophy if we were to ask the Federal Government to do this task.

Yet, the Federal Government is in the position of being faced with a major crisis. There have been instances where smog and smog problems have created not only chronic conditions injurious to health, economic welfare and prosperity, but where they have actually created acute conditions which have resulted in deaths and high illness rates directly attributable to abnormally high levels of air pollution. This situation is occurring with increasing frequency and effect.

I also took the trouble of looking up the most recent statistics on States which have air pollution control laws. I hope that since the statistics were compiled, there may have been some additional States which have air pollution control laws of one kind or another. But I find, for example, that Alabama, Iowa, Kansas, Maine, Mississippi, Montana, Nebraska, New Hampshire, New Mexico, North Dakota, Rhode Island, South Dakota, Vermont, and Wyoming have no air pollution control statutes. I find that there are State control laws with little or no enforcement powers in Arizona, Connecticut, Georgia, Nevada, North Carolina, Ohio, Oklahoma, Tennessee, Utah, and Washington.

We should say that the Federal Government is projected into this role of air pollution abatement by reason of long failure of many of the States, most of the municipalities, private industry, and private citizens, to really express in concrete action and legislative form an adequate concern over this problem and an adequate effort to abate the pollution.

I think it is fair to say that the views you are hearing here today are not necessarily the views of the entire Congress. They are the views of John Dingell, who happens to be a member of the Commerce Committee which has been working on this program on the national level for something in excess of ten years.

In 1955, the Congress began its first effort to combat air pollution. The Federal Air Pollution Control Act, adopted in that year, provided merely a program for research, technical assistance to State and local governments, training of technical personnel, and dissemination of information.

Subsequent to that time, the statute has been amended to conform to increases in technological information and the needs and wishes of the people in this country as expressed to their elected representatives. We have witnessed an increase in funding, which has been a very happy experience because it has encouraged significant local participation in the handling of local air pollution enforcement problems.

In addition to this, we have witnessed a change in the law somewhat in conformity with the Water Pollution Control Act, to authorize the Federal Government to begin air pollution abatement action where we see air pollution of interstate character. I'm sure you're aware that along the boundaries of many of our great States, particularly those which have large concentrations of industry, we have air pollution which is interstate in character. You will note that the Federal Government has not as of this time, begun the approach to air pollution as it has done in the field of water pollution, through an attack upon intrastate pollution.

The Federal air pollution control statute has now been beefed up by providing for Federal action on a reciprocal basis, when other nations point out air pollution originating in the United States and affecting life, health and welfare of people in other nations. This is as yet an untried section of the law, but one which offers some promise not only in obviating some rather strained international relations but also in providing a measure of advantage to our people at home.

Other Federal actions have been equally helpful in handling the problem of air pollution. Beginning steps have been made toward the encouragement of utilization of low sulfur-content fuels. Programs for the abatement of automobile crankcase and exhaust emissions were worked out by my committee, enacted into law by the Congress, and signed by the President. This was done in cooperation with the automobile industry, so that the standards and devices which will ultimately be used are those which will be economically feasible and technically effective.

It is fair to say, however, with the very best effort that can be made by everyone under the laws on the books, with the present standard of technological knowledge and information, that the rather dreary prospect is that air pollution will not really be controlled. We can anticipate by the middle 1980's that with the very best efforts, by all levels of government, by industry, and others, we will be falling backward in handling the problems of air pollution.

I believe that at a very early time those States and those communities which do not have adequate programs for the abatement of air pollution must get something meaningful on the books—something with teeth in it, with mechanisms for administrative as well as judicial enforcement.

A recent Senate Public Works Committee staff report on the most recent year for which reasonably complete figures were available shows that only 17 States were spending as much as $5,000 per year on air pollution control programs. Of the total expenditure of $2,000,000, 57 percent was spent by the State of California. Although these expenditures have been revised upward, the levels of expenditure are not yet adequate.

In 1961, there were some 85 local agencies budgeting at least $5,000 a year each for air pollution control. Of their total expenditure of some eight million dollars, 55 percent was spent in California in seven local units, with the Los Angeles County Air Pollution Control District accounting for over 41 percent of the money spent by local agencies throughout the United States.

On a per capita basis, Los Angeles spends today about 57 cents. The median expenditure for 85 local programs was only 10.8 cents per capita. Now the National Center for Air Pollution Control of the Public Health Service reports that a satisfactory air pollution control program for a community with average present-day problems requires an annual expenditure of something like 40 cents per capita. It would be fair to say that no community in this country, with the exception of Los Angeles, and perhaps one or two others, even comes close to approaching that level of expenditure.

I do not speak to you as an enemy of industry, or one who seeks to unduly cripple industry by imposing upon it measures beyond its legitimate responsibility. But I would point out that when industries engage in the manufacture of commodities for profit, it is their responsibility not only to produce and to sell, but to bear the burden of the economic waste, not project it upon or inflict it upon our society.

While it is true that industry is not the largest single contributor of pollution to our air, I would point out that it is industry's responsibility in the field of air pollution, as it is in the field of water pollution, to clean up and abate its pollution within the abilities of the technologies presently available. If they do not take vigorous steps to accomplish this, and they have not yet demonstrated their full capability under present technology, they will bear the result, not necessarily in the form of national legislative enactment, but certainly in the form of community and State action.

I intend at a very early time to introduce legislation to bring to a more current basis our Federal air pollution control statutes and to see to it that the Federal statutes reflect more fully our experience under the Federal Water Pollution Control Act, by establishing first of all, a meaningful program of national criteria for exhaust emissions and things of this kind.

I believe that I can point out to the U.S. Public Health Service, to industry, and to the State and local agencies that their full responsibility in this area has not yet properly been carried out. The most recent Clean Air Act required the Public Health Service to come forward with criteria for air cleanliness and air standards which have not yet been forthcoming.

When next my committee discusses legislation to further improve our efforts in abating the pollution of our air, this will be a matter of prime concern.

I think we must recognize that we are not farming now as well as we could. Not only does the economic welfare of this Nation hinge upon our ability and our efforts to clean up, but the very health of this Nation, the success of our agriculture, the well-being of our people and the future of our society will be governed by our efforts and by our successes in cleaning up pollution. This is the responsibility of all of us, including the national legislators, state legislators, the officials of the communities, industry, private citizens and every person in this country who requires for his life, for his existence the presence of an adequate supply of clean and pure air.

It is my hope that each of you will carry forth new information and new dedication to solve one of the great, pressing health problems which remain unsolved in this country.

QUESTIONS AND COMMENTS

REVEREND EARL H. CUNNINGHAM, Ph. D. (*Chairman, Air Pollution Committee, Area Councils Association, Cleveland, Ohio*): As chairman of a group of citizens which represents 15 community councils in Greater Cleveland, I'd like to ask Congressman Dingell if any funds are available to assist such groups. We have discovered that there are many things that we could do with proper funding. Right now, our funds depend upon either voluntary donations from a few individuals or Red Feather money, which of course has a million other claims upon it. And we would like to know if there are Federal funds available to enable us to undertake some remedial actions and some research projects to discover what further actions citizens' groups can take in order to really grapple with this problem.

DINGELL: I don't know whether or not there is a provision in the Federal statutes to help private organizations to engage in this activity. The last two amendments of the Clean Air Act included provisions for increased funding for communities to carry out this responsibility. I would be happy to check this and find out whether or not your particular group would fall into the definition of an eligible recipient for a Federal program grant.

CUNNINGHAM: We appreciate this. Congressman Vanik is looking into it, too, but we thought, since you were here, we should ask you also.

DINGELL: If Congressman Vanik is looking into it, you should get a good answer and a quick one.

RICHARD D. McCARTHY (*Member of Congress, 39th District, Buffalo, New York*): I'd like first to defer to my distinguished colleague from Michigan, Congressman Dingell, who is a member of the Committee that will write any new legislation in this field. Then I'd like to plead my case for eligibility to discuss this matter on the basis that I'm a member of the Public Works Committee where we produced the Water Quality Act of 1965, and then the Clean Rivers Act of 1966. And my experience in the field of water pollution has led me to certain convictions which have only been confirmed here in the last two days. One of them is that we need legislation, and I hope that my bill, which will be introduced on the opening day, will be complementary and supplementary to the bill that Congressman Dingell will introduce.

My bill will have four basic fundamentals. The first is designed to establish the Federal Government in a leadership role in partnership with State and local governments. The second is to establish the program on an interstate or regional basis, through research into airshed air currents. Preliminary research indicates that air movements transcend boundaries to a far greater extent than the layman presently conceives. The third fundamental is to establish emission standards, industry by industry, and the fourth, to establish air quality standards.

We also need new legislation to accelerate development of a turbine or electric car, and there have been bills introduced previously, by Senator Magnuson, Congressman Ottinger, and others, to accomplish this.

I certainly agree with Mr. Thayer that we do need tax incentives, and I might point out that the Clean Rivers Act of 1966 provides for a study to be completed next July in consultation with industry to determine what kind of tax incentive would be best. This would cover both water and air pollution. Finally, I think that in the long run this function could better be handled by the Interior Department. I think they picked up the job on water pollution very vigorously. Eventually, I would envision a transfer of this function from HEW, overburdened with education, labor, and welfare matters, to the Interior Department.

LEWIS C. GREEN *(Chairman, Air Conservation Commission of Missouri, St. Louis)*: Do you favor Vice President Humphrey's call for national standards for control or do you think strong effective interstate compacts offer a realistic alternative to regional control?

DINGELL: I favor, as I have indicated in my remarks, the establishment of nationwide emission standards and am presently having legislation drafted to accomplish this end. I also favor use of tax incentives and it was for this reason that Congressman Vivian of Michigan and I cooperated to bring to the attention of the House of Representatives the need for tax incentives and the continuance of the 7-percent industrial credit.

I feel that there is also a place in the handling of pollution problems for interstate compacts. I would point out to you, however, that the record of interstate compacts in the handling of water pollution problems is a sorry one.

I have rather frequently over the years received from one of the larger compact areas a statement of what has been accomplished there, done upon beautiful slick paper, obviously a very expensive printing job, citing the records of progress in the area; and I have had occasion to review these very nice handouts very carefully. In many cases, I returned them to their authors with a series of rather pointed comments which made it very clear that the best side only had been pointed up and that, in fact, very little had been accomplished. I noted during the past year that my statement on this point was buttressed by the commencement of two Federal water pollution abatement actions in the areas where two of these compacts operated, to enforce cleanup of the very badly polluted situation, interstate in character, which the compact was supposed to attack and which it had not done.

We have no experience in the area of air pollution with the working of interstate compacts. But if the record of air pollution compacts equals that of water pollution compacts, we will be in a very sorry mess, one so bad that we will be compelled to see the Federal Government go in to commence abatement actions again, to clean up the pollution which arises because of inadequate efforts by the compact authorities. On the basis of a long record in the field of water pollution control by compacts, I believe that these have demonstrated either an inadequacy of interest or an inadequacy of capability to attack the pollution problem they were charged with handling.

". . . writer . . . author of "With Every Breath You Take" . . . member of Columbia University journalism faculty. . . ."

A TIME FOR IMAGINATION

HOWARD R. LEWIS
Author
New York City

I tend to take air pollution rather personally. Sometimes I remind myself of the hero of the satirical novel *Catch 22.* This fellow is a World War II Air Force pilot who gets scared stiff one day when he suddenly realizes, "They're shooting at *me*!"

This, I think, is the best attitude anyone can take toward air pollution: "They're poisoning *me*!" There is very much of a human element in air pollution. It affects virtually every part of life. I think right now of my own family. We're planning to move out of our apartment in Manhattan. One of the reasons is that we have a baby son who's starting to crawl.

My wife Martha is a meticulous housekeeper, but she cannot keep the house clean. It revolts us that when the baby crawls on the floor, he comes up black. This has about the same effect on my stomach as a ring around a bathtub. So we're going to move.

Occasionally we get very angry about this, because we figure why should we have to move so the Consolidated Edison Company can send some junk up a stack, so the landlords across the street can pour their garbage into our living room. This is really infringing on our private life, and we take it very, very personally.

Thus I more than share the ideals implicit in this conference: that air pollution should be reduced, that the air should be clean.

We're talking about dreams and realities. Dreams abound all through the air pollution business. One of the charming fringe benefits of having written *With Every Breath You Take* is that I get phone calls from all sorts of odd people. There is a lady who lives in the Bronx who calls me up about every month or so. She tells me that she knows there's a tremendous air pollution problem in her neighborhood because she sees great black clouds of carbon monoxide coming through her walls.

Well, *our* dream is that the air should not be polluted. We want to convert this into reality, and we want to go from the ideal to the practical.

One of the problems of air pollution control is that it does not have a constituency to speak of. Two years ago, when I was researching *With Every Breath You Take*, I discovered that people didn't know there was any air pollution problem. They didn't even know what air pollution was. They thought it had to do with bad radio broadcasts.

Once it was a particularly bad day, a terribly, terribly smoggy day in New York. It was one of those days when you could barely see Brooklyn across the East River. The air was sour to the taste; it was painful to breathe. If you breathed it too long and were out too much, you felt that the flu was coming on. I was driving up the East River Drive with a friend who certainly is worldly and intelligent, and he said, "I hear you're writing a book about air pollution. Tell me, is New York's air polluted?"

We thought at the time that if we could only tell people that we have polluted air and give them enough information, they would start clamoring for smog control. But we found out that information is not enough.

Over the Thanksgiving holiday we had an air pollution emergency. Previously relatively little attention was paid in the press to air pollution. *After* the Thanksgiving emergency, there was very little question that we have smog in New York. The *New York News*, the nation's most widely-read newspaper, ran a headline saying "SMOG PASSES DANGER MARK. . . . Urge Patients to Stay in Bed . . ." If this left any doubt that we have a smog problem in New York, it's only among the illiterate population.

But even though information is now widespread, there is a lack of response on the part of the public. Many people are not convinced that air pollution hurts them. Even if they do believe that smog is injurious, they are not willing to act against it. They are not persuaded that the hazard presented by air pollution is sufficient to offset the pressure of their own immediate and narrow interests. One week after the smog emergency, landlords and tenants were storming City Hall protesting the proposal for new incineration devices to reduce air pollution. We had had an emergency, but nothing really got through.

Air pollution control has not captured the imagination of the public. One of the things needed is a local group to speak up in favor of effective air pollution control and to offset the kind of pressure that is exerted by polluting groups.

There is an effective organization in California called S.O.S. The letters stand for *Stamp Out Smog*. The organization started with nine women, who act as a spearhead for a large number of California groups. They provide a continuing role in support of the air pollution control program in California. There is another promising group in New York, the Citizens for Clean Air. There certainly was an effective program passed for getting rid of smoke, although not most other emissions, in Pittsburgh.

One of the speakers on this program has said: "Emotionally influenced legislation will not solve air pollution problems." I cannot disagree more. It is only by getting to the emotions that we are ever going to get any kind of progress towards a solution of air pollution.

There needs to be a broad base of support of air pollution control. Air pollution is largely considered an engineering problem. And yet, to most of us, the only way of reaching the public and getting legislation is by making it a medical problem.

The public should be reminded about the effects of air pollution: emphysema, heart disease, cancer, mass deaths. This will build up their emotional involvement in air pollution. We must convince people that they do have a life stake in air pollution control.

Once we have a public aware of air pollution and eager to press for controls, where do we go from there?

We've heard speakers on this panel say that since industry has contributed to air pollution problems, it should therefore be the responsibility of industry to solve those problems. These speakers offer the proposition that American industry, although motivated by profit and competition, also has the desire to be a good neighbor.

This is certainly true of individual public-spirited companies. But I suggest that anyone who feels that industry by itself can be relied on to be a good neighbor, ought to visit New Jersey. Preferably he should bring along a clothespin to wear over his nose, because there are refineries along the New Jersey coast whose emissions have killed truck farming and flower growing in Staten Island and have rendered some surrounding sections as barren of vegetation as the face of the moon.

Then, go down the coast of the United States to Hillsborough and Polk Counties in Florida, where phosphate plants pour out fluorides. These fluorides get into vegetation that is eaten by cattle. This used to be the largest cattle-producing area in Florida. The cattle, however, when they take in fluorides develop soft bones and weak teeth. After a while they can't eat any more, because their teeth are worn down to the gums. They can't stand up any more, because their bones won't support them. It's considered an act of kindness by the local ranchers to shoot the cattle to put them out of their misery.

Then review the transcript of the Muskie hearings. Representatives of the Automobile Manufacturers Association, speaking against the Clean Air Act, said flatly that they would exercise only the controls that were required by law. The result was an amendment to the Clean Air Act, providing for motor-vehicle control.

If any further proof is needed that regulation spurs industry to act like a good neighbor, I suggest you visit Los Angeles. Many nationwide industries have big installations in the Los Angeles area. Throughout the country, these same companies do very little to control their emissions. But in Los Angeles their plants employ rigorous pollution control devices and methods. The reason, of course, lies in the fact that the Los Angeles County Air Pollution Control District has stiff regulations and can impose heavy penalties.

In Weirton, West Virginia, there's one of the largest steel plants in the country. It dominates the town's economy. A couple of years ago, this steel plant had a burst of carbon monoxide through a defective furnace. Following a meteorologic pattern, the carbon monoxide traveled through the air and bombed a house, leaving 13 people gasping for breath. Two were hospitalized.

The Public Health Service volunteered to go to the steel plant and find out the origin of the emission. They were willing to do this free to prevent the recurrence of the problem. But they were refused permission to enter the community. Under the regulations they could only come in at the request of the local officials. The town officials went along with the steel plant and refused to permit the Public Health Service to investigate the problem.

We are talking about a problem that cannot be solved by any of the existing local entities of government. John Gardner, the Secretary of Health, Education, and Welfare, has a very apt phrase. He speaks of the "crisis of organization." This crisis is found in air pollution control, for air pollution—which willy-nilly crosses political boundaries—is something that our present modes of government have not provided for.

We are well aware that air pollution is part of the woof and warp of American life. Yet this is something that the framers of the Constitution and the drafters of laws could not have foreseen. Air pollution, in its present degree, is a whole new problem, but we have only traditional political mechanisms with which to deal with it.

This might present no problem if polluters were installing controls on their own. But industry is often unwilling to do this, and sometimes unable to, for it can be uneconomic to reduce emissions unless competing companies also do. This is yet another argument for uniform regulations: installation of controls would no longer be a competitive factor.

The traditional political entities might also not impede air pollution control if local government were meeting the problem effectively. But most local areas don't have air pollution agencies worthy of the name. Many States do not have programs. Those States that do have programs tend to have very anemic ones.

The States are underbudgeted and relatively inactive. At the community level, the situation is worse: The programs not only lack teeth: they barely have gums. Also, there's a fragmentation of responsibility that bars workable programs. I'm still impressed by learning that in Texas the state air pollution agency has to work through no fewer than 135 counties.

Thus we have to think not only in terms of more effective controls, but also in terms of more effective methods of government. Right now we have barely a glimmering of regional planning. We need a whole lot more of it.

We also need to welcome a whole lot more Federal participation. I wish this weren't necessary, for there's a great deal to be said for the responsibility of local government to local needs. And certainly where local programs work they should be retained and built on. But in general—just as a matter of practicality—the Federal Government is virtually the only instrumentality in the Nation that has the technical resources and the funds to do the job that's needed for setting standards for air quality and for basic, nationwide program provisions.

The Federal Government is also less vulnerable to the kind of pressure that keeps programs from getting organized at the local level. And it is also in a position to use the carrot technique instead of the stick. The Federal Government could help pay for any local operation that meets its standards. This is how it traditionally works in health areas: the Federal Government sets minimum standards and then it requires local health departments to meet these standards; if they don't meet the standards, then they don't get Federal reimbursement.

We also have to start using imagination to solve this problem. We have to start challenging old concepts. Why must the State, States' rights and local agencies necessarily be the units of enforcement of air pollution control? In many cases, State and local governments do indeed do the best job. But why can't we think in terms of other organizations of government?

There is another concept I recommend to your attention: the airshed. The communities in an airshed have interrelated conditions of weather and air pollution. For example, parts of New York, New Jersey and Connecticut comprise one airshed. What's needed in the airsheds are suprastate agencies that could incorporate large areas of several states. They could be regulated by the Federal Government, or represent the member States, or combine Federal-State-local jurisdictions—whatever works best. This is a new, pragmatic way of looking at a new, very real problem.

However, establishing regional controls won't be easy. There are vested interests in maintaining the present systems of government. Every local official is also a lobbyist for his own agency. It's a very difficult thing to get regional plans to work because new organizations run counter to established ones. Defense of the status quo exists everywhere. Added to this is the fact that in some circles the Federal Government is regarded as a foreign aggressor, and States' rights is an object of devotion akin to motherhood and cleanliness.

We have the ideals; we have standards; we now know what is going up a stack and what is going into the air; we now even have a notion of where the different levels of government should be in respect to air pollution control.

What do we do now? What kind of political instrumentalities are necessary? What kind of public support is necessary? What kind of government officials are needed? These are going to be the crucial questions in the field of air pollution control.

Before we answer them, we are going to have to do one last thing: We are going to have to overcome a national attitude of complacency. Americans are used to thinking in terms of a brighter tomorrow. We're very optimistic people. Unfortunately, this optimism is not justified by the facts.

Because, as we're proceeding now, the air is getting filthy and foul and more unfit to breathe.

We're going to go down in history as a nation of innovators, as perhaps the most imaginative people who have ever lived. We have introduced in our own time an age of scientific wonders. We have unparalleled prosperity. We have conquered frontiers on our own continent; we have also conquered new frontiers in science, and we've conquered frontiers in space.

And what a pity it will be if we can't overcome a problem of our own making. Until we get the kind of controls that are needed, you and the people you know and the people you love are going to be inhaling a small but significant amount of poison with every breath. The sky is going to be dark at noon. We're going to be condemning ourselves to a polluted present. We're going to be condemning our children to a foul future.

We need to end this plague. We need to exercise imagination. We need to try new tactics; we need to take new approaches; we need to call on new resources. We had better do so quickly, because there's not much time left.

H

December 13, 1966

PANEL H

ECONOMIC AND SOCIAL ASPECTS OF AIR POLLUTION CONTROL

FIRST SESSION

Chairman Robert G. Howes
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Regional Planning,
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". . . ordained a priest in 1951 . . . degrees in liberal arts, theology and city planning from four universities . . . authority on community relations . . ."

STATUS REPORT

ROBERT G. HOWES
Chairman,
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My initial reaction to the telephone call which invited me to chair this panel was at best unsure. I am not an engineer. I have never been elected to anything even remotely metropolitan. I'm not even a monsignor. But, on second thought, as I began to touch the subject more closely and felt pulsing through it the urgency of an informed citizen presence, I was less unsure. On third thought, I accepted.

My own involvement here is triple. In the first place, I'm a preacher, and healthy air is a human right for every citizen in a more and more metropolitan U.S.A. Air pollution is a variable which must be figured importantly into any equation for happiness in the civilization to which I preach. Churchmen have been, in many cities, leaders in the fight for civil rights, and I submit that churchmen, joined with other citizen educators, must be leaders in moving the national conscience to action for the human right of healthy air.

Second, I am a teacher and a city planner. I direct the education of other prospective city planners. How we site our cities, how we move in them, the way we work and where, what we burn and waste, these are common concerns for the planner and the air pollution expert.

The environmental pollution panel of President Johnson's Science Advisory Committee, in November 1965, pointed to city planning as "an essential consideration in effective pollution control."

Third, I write poetry, and increasingly the poetry of our life together in cities, from the sonnet of white washes blowing on Monday clotheslines to coughless leisure and the rhythm of interstitial urban green, is muffled by the roar from unfriendly skies.

I suggest that our purpose here is how to isolate, then to integrate in cost-benefit, what it will take in money, government, and adjusted human habits to cleanse the air we breathe. Our goal remains that which was set in the Pennsylvania air pollution control act of a few years ago, to assure an air purity which is "technically feasible, economically reasonable, and necessary for the protection of the normal health, the general welfare and the property of the American people."

In the course of this historic conference, we have heard much expert witness. We shall hear more today and tomorrow. It is not my job either to repeat what has been said or to say what most probably will be said better. It is my task to pose that complex of societal questions which seems to be at base here. To do so adequately requires the remembrance of four benchmarks.

First, the problem of air pollution control is not static, nor is its projected growth a gentle curve. Mr. Crawford, President of New York's Consolidated Edison, has called this our "effluent society." We shall become more effluent tomorrow and notably more effluent the day after tomorrow. Ten years from now, New York City will require twice as much energy as it uses today. Fifteen years from now, twice as much electricity will have to be generated to meet our national needs; twice as much coal and natural gas will be burned, and three times as much oil. Twenty-five years from now, our overall energy use will have tripled. Combine with this a jump from 88 million cars, trucks and buses on all our roads last year to an estimate of 111 million in 1985, and the dimensions of the air pollution control problem become clear. Senator Muskie has said, "I don't think we've even scratched the surface." In short, we cannot stand still; neither can we extrapolate timidly forward from our early starts.

It seems certain that government at all levels will need to devote more time, more and better monitoring equipment, more technical personnel in intermediate as well as directive capacities, to write more laws, to impose more fines, to place more incentives, to create more and wiser authorities if we are to keep even with, much less reduce, this multiplying problem.

I suggest this means new fiscal commitments, backed by new political patience and courage.

Second, the problem of adequate air pollution control cannot be solved by better machines only. We shall simply not move the necessary moneys through politics in a critically competitive fiscal market unless and until the American people (a) recognize the need for an omnipresent air control dimension in their society; (b) demand it; and (c) are educated to accept its costs, as well as the personal and collective readjustment in their life habits which it will entail.

As a city planner, it's that readjustment in land controls and the stringency of regulations as to uses and placement of various land activities that concern me most.

Perhaps the principal city planner active in air pollution control planning is Matthew Rockwell, executive director of the Northeastern Illinois Metropolitan Area Planning Commission. "The key issue," Rockwell contends, "is whether or not we care enough about the problem. How much do we care? How much are we willing to sacrifice for clean air?"

New York City's epochal *Freedom to Breathe* salutes Pittsburgh, St. Louis and Los Angeles, noting that "all three cities had in common one great resource. Nothing effective was done or could have been done until citizen action created a ground swell of support for official measures."

Third, the problem of adequate air pollution control cannot be solved short of a systems approach. Alvin Schorr has defined poverty as a "syndrome of reinforcing handicaps." Environmental pollution is a system of pollutants, polluting habits, and a machine society which at one and the same time enlarges our urban options and increases our urban wastes. What is urgently required, we've been told again and again, is air management—a system of reinforcing incentives, moneys, penalties, plus a new commitment of the national conscience.

In *Freedom to Breathe*, New York City goes even further. It identifies a multi-environmental effect involving air pollution, water pollution, noise, and refuse disposal. It calls for the creation of an environmental control board, concluding, "No major improvement can be accomplished in the quality of New York's air until the problem is regarded as an indigenous part of the whole environment. The city needs a system for interrelating and coordinating problems of air pollution control, water pollution control, solid waste disposal, noise abatement, congestion, and protection of both natural and manmade facilities that give pleasure and well-being to its citizens."

Fourth, the problem of adequate air pollution control must be met at the local as well as at the regional and federal government level. *Freedom to Breathe* identifies New York City itself, as "the worst violator of its own laws against air pollution."

Cities, however, are only citizens to the *nth* power. If public incinerators, buses, road-building and maintenance, housing, and smokestacks are to be effectively cleansed, new citizen decision and new citizen tax involvements are clearly urgent.

Around such benchmarks as these, questions emerge. We have already had limited local pollution disasters. Thanksgiving Day in New York City, we passed the point of tolerance, and I have been wondering if this caused notable change in citizen attitude toward pollution. There is little evidence of potential willingness to sacrifice for clean air.

Must there be a major urban catastrophe before we have adequate air management in Megalopolis, U.S.A.?

What hope is there for a reasonably neat and relatively clean solution to the problem of substituting cheap and safe nuclear energy for polluting fuels? What will be the human fallout from such conversion on the coal and oil industries and on the coal and oil economies?

Given that much expensive remedial action will be required in the private sector, to what extent shall the public share the costs of fuel conversion and installation of air control devices?

City Planner Rockwell spelled out some of the potential planning requirements for effective air control in a speech on the chronology of our relation as city planners to the problem of air pollution. He says, "If we're going to have effective planning to cooperate with the air pollution control people, there are going to be some severe changes required in the acceptance of various stringent land controls." He says also, "We should expand the definition of blight to include those areas where excessive amounts of pollution effects from space-heating sources are present. . . . Renewal and housing agencies should insist on pollution control measures before approving new projects. . . . Do we care enough to regulate volumes of traffic, plan new expressways, propose additional mass transit facilities so that automobile pollution is minimized even more through transportation planning? . . . Do we care enough about absolute amounts of uncontrolled pollution from industrial processes to require that air pollution effects be measured prior to approval of new industrial plants sites? . . . How far do we want to go in the control of incineration?"

Mr. Rockwell comes up with the rather staggering conclusion that if air control is to be effective through planning in the Northeastern Illinois area, all the new industrial plants southeast of Chicago would have to be banned.

Will the American people and their elected officials in sufficient number accept this kind of new stringency in land controls? Should we be introducing as a regular feature in the processes of government a mandatory referral factor in which all land use and circulation proposals, at least in the metropolitan areas, are referred prior to activation to air management authority?

If, indeed, one of the major problems in effecting air management is that the problem itself is not really felt by most Americans, how can we step up our public relations campaign? Was Gladwin Hill right when he wrote in the New York Times, "The most important part of a program is not technical expertise: it's having a wheeler-dealer who can put it across with the political establishment in the community." We've been long on engineering, and short on wheeler-dealers.

We shall, I trust, here answer these and related questions. In the largest sense, the only real answer can come from an informed and angry electorate.

We have got, as is the case with all planning, somehow to translate the big picture into phrases, benefits, and obligations understandable to the little guy with the ordinary family on the plain metropolitan street. We've got to make our case so clear and so comprehensible and so compelling that the nation will want to act before disaster strikes.

In the transition from this conference to that action, I call upon middle leadership, on citizen educators everywhere and constantly, our universities, our churches and synagogues, our labor and management organizations, particularly, to play a principal role.

". . . economist . . . consultant to WHO, National Academy of Sciences, Office of Science and Technology . . . author of books on economics of environmental pollution . . ."

HOW MUCH IS AIR POLLUTION COSTING US IN THE UNITED STATES?

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Even casual followers of the air pollution literature must notice that a lot of divergent things are being said about the cost of pollution to the nation. Estimates cited within the past few years range from 4 to 20 billion dollars per year. There are discernible reasons for this wide range: (a) the figures given are all guesses based on the most slender evidence; (b) they obviously differ in inclusiveness although what they are meant to encompass is usually not clearly stated. While I feel that estimates of national pollution costs are of rather limited utility as an aid to decision-making, it is perhaps useful to linger over the matter a bit because these figures are so frequently and prominently quoted and they do have a certain usefulness.

In connection with the first point, i.e., that they are all guesses, let me describe briefly what a modest amount of checking turns up concerning the origin of the $11 billion figure now most commonly cited—it appears dozens of times in the literature. The figure is the rounded result of multiplying $60 by the national population in 1958.[1]

The apparent source for this per capita figure is a 1959 extrapolation from Pittsburgh data dealing primarily with smoke damage. These data were collected by the Mellon Institute in 1913.[2] Perhaps one can be forgiven for suspecting that this information is somewhat dated.

Reasonably careful review of the literature and conversations with knowledgeable persons reveal no more solid base for the national cost estimates than this fragment of information about per capita costs under very special circumstances multiplied by an irrelevant population figure.[3] Without throwing stones at efforts to provide some illumination in this vast darkness, may I suggest that it would be appropriate to stop citing these figures immediately.

Since it appears, however, that some national cost figure is going to be cited and since estimates of national cost do have a certain usefulness, we should make at least a modest effort to improve them. One tentative step in this direction has been taken. Following a technique developed by the Beaver Committee [4] in England, Ronald Ridker [5] has produced a figure of about $5.5 billion for 1963. Ridker identified a wide variety of potential effects of air pollution, including costs of maintenance of residential, commercial, and industrial facilities, damage to trees and agricultural crops and livestock, costs associated with the illness and death of humans, etc. His technique was in general to obtain estimates of total costs of maintenance, damage, costs of illness, etc.

associated with all causes and then to estimate a proportion due to air pollution. In some instances, however, direct estimates of pollution damage were used.

There are two major difficulties with Ridker's estimates. First, while he used the best information available, there are severe problems in the underlying gross cost estimates. For example, real psychic costs of illness or death not reflected in medical outlays, lost productivity, and burial expenses are excluded from existing estimates of ill health and death losses. Similarly, purely esthetic effects of air pollution are also excluded except to the extent that they are reflected in some estimates based on property values. If possible, the estimates of gross damage should be improved in these respects and where hard-core incommensurables occur the numbers presented should be carefully and clearly qualified. The other major problem is in determination of the proportion of gross costs—repainting of structures and medical expenditures, for example—that can reasonably be attributed to air pollution effects. Here, Ridker often had to rely on extremely tenuous evidence, sometimes even using the proportions which the Beaver Report had specified for England. One may wonder how much scrutiny these could withstand even for England, not to mention their applicability to the United States.

Despite these shortcomings, Ridker's effort is the only one which takes a reasonably systematic and defensible approach to the problem and I think it is amenable to improvement. One possibility would be to put some more research time into refining Ridker's estimates and then convene a small high-level expert body to review them. The judgment of the experts could be helpful in making further improvements. At least they would be guessing within a meaningful and reasonably comprehensive framework of questions.

It would be particularly helpful if they could provide the basis for some estimate of the effects of national control policy on damage costs. For example, how much would damage costs be reduced by alternative levels of automobile emission controls? Such estimates might provide the basis for some rough cost-benefit analysis.

But what good are the national estimates? I have just suggested one application—when a national policy is involved, such as national standards for auto emissions, estimates of the effects associated with the pollutant and anticipated changes resulting from control are useful.[6] Furthermore, estimates of cost can be important to the politician in Washington who must have some basis for deciding where this problem stands in the hierarchy of national headaches and what proportion of research and other funds should be directed toward it. Perhaps it is also important to give the public some overall perspective concerning the seriousness of the problem.

CONCEPTS OF COST

This gets to the second matter which I raised at the beginning of my presentation. What should be included, for the various possible purposes, in the estimates of costs? In addressing this matter, I think it will help to refer to a simple diagram which will also aid in understanding some of the points later in the paper.

In Figure 1 costs and gains are measured in dollars on the y-axis and level of pollution control is measured on the x-axis.[7]

The curves permit easy representation of the relevant benefits and costs concepts. The rising line (incremental cost of control) represents at each potential level of control what the last small increment of control costs. The falling line (incremental reduction in damage costs or incremental benefits) shows for each potential level of control how much the last small increment of control reduced damages. It is a convenient feature of such incremental lines that the area under them represents the total value of which they show an increment. In other words, if we look at control level x_2, the double crosshatched area under IC shows the total control cost for that level of control. Similarly, the crosshatched area under IB beyond x_2 shows the total residual damage which is left after control level x_2 has been achieved. The two together show the total costs associated with pollution—damage costs plus control costs. This combined figure is one the national decision maker might well be interested in as a gauge of the national importance of the problem. It may also suggest whether the level of research being devoted to reducing damage control costs and otherwise controlling damages is appropriate.[8]

The traditional benefit-cost ratio $(\frac{B}{C})$ is a little harder to show, but it is the double crosshatched area plus the single crosshatched area (total reduction in damages= gross benefit) over the double crosshatched area (total control cost) all to the left of control level x_2.

The benefit-cost ratio may sometimes be a useful gross guide as to whether investment in control is justified. Clearly, if overall costs exceed benefits, there is a severe question about the justifiability of the level of control achieved. But it is not necessarily true that if benefits exceed costs, i.e., the ratio is higher than unity, that higher levels of control should be sought. In the grossly oversimplified conditions depicted in the chart, we can easily see where the economic optimum lies. It is at control level x_2. At that point, the last small increment of control has yielded damage reduction just equal to what it costs. If we undertook a further increment, the increase in cost would outweigh the increase in the value of damage control and overall costs (control plus damage) would rise. On the other hand, if we did not carry control to point x_2, we would be foregoing opportunities to reduce overall costs or, said differently, to obtain net benefits.

For instance, if control were carried only to point x_1, a further unit of control would cost only about half as much as the damage cost it saves. Note that at the optimum point x_2 the benefit-cost ratio is well above unity. Thus, while knowledge of overall cost and benefits may be useful, knowing how a change in control would affect costs and benefits is usually more important for decision-making.[9] Making improved decisions based on economic data does not *necessarily* require that we know the total costs and gains at all.

ESTIMATES OF COSTS AT THE "PROBLEM SHED" LEVEL

While the framework outlined here is grossly oversimplified, it provides useful organizing principles for considering the matter of national costs associated with air pollution.

Reasonably systematic analysis of damage and control costs is, however, usually more feasible and more directly relevant to decision-making at the "problem shed" [10] level than the national level. What is the state of economic analysis for problem sheds? It is my impression that no more than a scattering of more or less crude economic studies is available.[11] The casualness of many of the studies contrasts strikingly with the precision with which physical or chemical measurements are usually made—measuring concentrations in the parts per billion range is commonplace these days.

Before taking a look at some economic studies, let us outline what sorts of things it might be important to measure or esti-

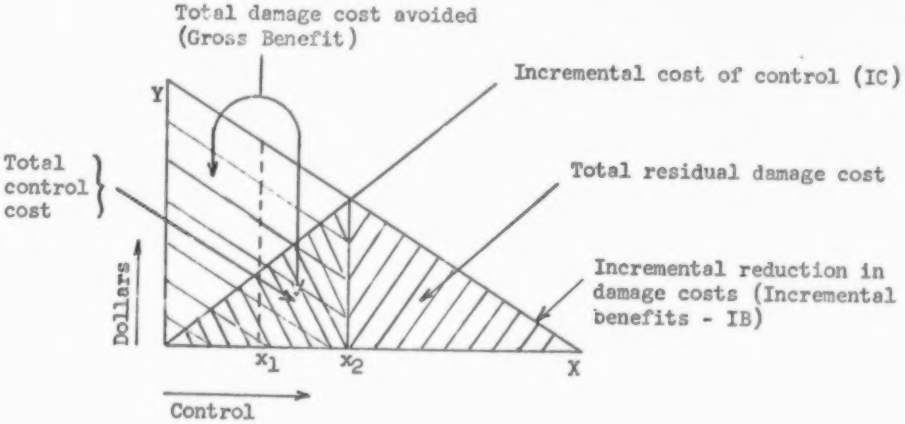

FIGURE 1

mate in a "problem shed." This will provide a basis for assessing where we stand in terms of providing economic information for decision-making.

- I. Damage costs
  - a. Effects of pollution on living things.
    - 1. Humans
    - 2. Livestock
    - 3. Plants
  - b. Corrosion and other deterioration of materials.
  - c. Maintenance and cleaning of objects exposed to pollution.
  - d. Losses due indirectly to pollution—effects of smog on transport costs, power for added illumination, etc.
- II. Control costs using existing technologies and approaches
  - a. Equipment—precipitators, afterburners, scrubbers, etc.
  - b. Fuel modification (desulfurization of fuel oil, for example).
  - c. Extended solid waste collections and disposal systems as a substitute for incineration.
  - d. Extended mass transit as a substitute for private automobiles.
  - e. Indirect effects bearing on costs.
    - 1. Administrative costs of control programs.
    - 2. Water pollution or landscape pollution resulting from conversion of gaseous to solid liquid wastes.
    - 3. Indirect waste control, i.e., treatment of waste water from stack-gas scrubbing operations.
    - 4. Value of materials recovered in pollution control process.
  - f. Costs of relocating existing economic activities or modifying future locations—those of thermal powerplants, for axample.
- III. New technologies
  - a. Substitutes for existing pollution-causing transportation systems—electric cars, moving sidewalks, etc.
  - b. Master gaseous waste collection and treatment systems.
  - c. Process and product modifications.

Clearly, some of these items will not be relevant in particular "problem sheds" and can be dismissed after brief reflection. But still in any large metropolitan area—where air pollution problems are likely to be concentrated—a good many of them will be relevant.

What do we know about the economics of these various categories?

Damage Cost Studies in "Problem Sheds."[12]

Under category I, I think it is fair to say that we have a small scattering of somewhat useful studies for a few locations.

(a) *Studies of direct damages*

The 1913 Mellon Institute study in Pittsburgh, an extrapolation of which appears to underlie the currently popular national costs figure, has already been mentioned. In addition, there have been a few other efforts to assess costs relating to materials damage and extra maintenance, i.e., urban damages other than those to esthetics or health. One such effort is reported in *Investigation to Determine the Possible Need for a Regulation on Organic Emissions from Stationary Sources in the San Francisco Bay Area* by the Bay Area Air Pollution Control District. This report is impressive for its detailed discussion of photochemical smog effects. It presents estimates of damage to agriculture, fabrics, rubber, electrical contact points, and paint. This is one of the very few instances where efforts at damage cost evaluation were even attempted in assessing the desirability of a control program. But it must be said that after detailed and technical discussion of the physical and chemical processes involved, the cost estimates usually turned out to be the roughest sort of guesses. The estimate of damage to paint may be used as an illustration. It is noted that the (omnipresent) Beaver Report estimated per capita losses in England at $1.70 per year. Because of the cleaner fuel burned in the Bay Area, it is assumed that an estimate of half that amount would be appropriate. Multiplied by the Bay Area population, the total cost is about $3 million.[13] As in almost all damage studies, no effort is made to relate damages to alternative levels of control.

Ridker has demonstrated how difficult it is to improve materials damage estimates by use of published data.[14] He attempted correlation of polllution levels as reported in the National Air Sampling Network Data for a number of cities with a variety of information on maintenance, repainting, cleaning, etc., with uniformly negative results. He also pointed out that the typical experimental approach used with materials is of little direct value in attempting to obtain economic loss functions. Typically in these studies, pure metals are exposed in locations of high pollution[15] or cloth is stretched tautly over a frame and similarly exposed. But pure uncoated metals are not commonly used in the economy and cloth is not normally stretched tautly over a frame, nor are commercial articles ordinarily so directly exposed to intensive pollution. Ridker suggests that what we need for economic studies are experimental data derived from observations on economic objects in conditions corresponding closely to actual use, and measurements on these objects of either the direct loss in economic function or the loss incurred to avoid or offset such direct losses. Scale models might be useful in this activity. If we are to have more than the crudest guesses of the cost of materials damage, this kind of approach should be tried.

Another technique entirely is to ask persons in different pollution situations how much they spend or would be willing to spend for various activities related to materials damage and soiling. Such a study was recently reported. It compared results of questionnaires concerning pollution-related expenditures for Steubenville, Ohio (relatively polluted), and Uniontown, Pennsylvania (relatively clean).[16] The study found that there was indeed a claimed cost difference of $84 per capita per year between Steubenville and Uniontown. It was also found that income level greatly influenced pollution-related expenditures. The authors view their undertaking as a pilot study. In fact, it is a long way from providing information on economic losses as a function of type and concentration of pollution. But questionnaire interview studies have demonstrated their ability to obtain information on perception of air pollution and attitudes toward it[17] and they merit additional trials as a means of obtaining economic information.[18]

(b) *Property value studies*

Of course, none of the studies so far discussed takes any account of esthetic losses due to letting materials deteriorate and allowing the environment to become soiled and undesirable. Reasoning about rational economic behavior, as well as observation, tells us that individuals will not fully counteract the effects of air pollution through cleaning, maintenance, air filtration, etc. But we know that the residual effects nevertheless represent losses of welfare to those suffering them and after all, human welfare is the fundamental concern of economics. These considerations plus the fact that data are often relatively easy to obtain make it attractive to try to measure the impact of air pollution on property values. Property values can be a surrogate for all the various direct and indirect impacts of an adverse environmental change. This has been explained as follows: ". . . so far as air pollution is concerned, there is one market that is more likely than others to reflect the majority of effects. This is the land, or real estate, market. If the land market were to work perfectly, the price of a plot of land would equal the sum of the present discounted stream of benefits and costs derivable from it. If some of its cost rise (e.g., additional maintenance and cleaning costs are required) or some of its benefits fall (e.g., one cannot see the mountains from the terrace), the property will be discounted in the market to reflect people's evaluation of these changes. Since air pollution is specific to locations and the supply of locations is fixed, there is less likelihood that the negative effects of pollution can be significantly shifted onto other markets. We should, therefore, expect to find the majority of effects reflected in this market, and can measure them by observing associated changes in property value."[19]

This idea sounds simple; putting it to use is far from simple. Great statistical ingenuity is needed to isolate the effect of one element—air pollution—bearing upon property values from all other determinants. Nevertheless, analysis has now made clear that impacts on land values and therefore upon all the human values which attach to particular sites can be substantial. A study in St. Louis found that property values are linearly related to mean annual sulfation rates. When sulfation levels were divided into eight equal zones of rising intensity, values appeared to decline about $250 per lot, per zone, other things remaining constant.[20] This would appear to be enough to justify even a costly control effort, but it also seems that the disbenefit that people attach to air pollution is finite and possibly fairly measurable. It does not suggest that total prohibition on use of the air's assimilative capacity is usually the right answer. The problem, rather, is one of determining costs and gains.

A property value study of a more limited range of affected interests in connection with a pollution problem in Polk County, Florida has also produced significant results. Variables, including one representing its frequency of fluoride pollution fumigation of property supporting citrus groves[21] were correlated with the sales price of citrus properties. This variable was found to be significantly related to the sales prices of the properties. In general, the results indicated that a substantial portion of the Polk County citrus industry suffered moderate damages from atmospheric fluoride emissions during the years (1956–62, approximately) in which these emissions were at their historical maximum.

The results of these studies are very encouraging and differ from those of all other studies I have seen in that they take us at least a step toward defining a functional relationship between air quality and economic loss.

A general shortcoming of economic studies has been that they have treated a stochastic or probabilistic phenomenon as being deterministic. In their own way air pollution episodes are a good deal like floods. They vary in intensity over time—perhaps randomly. Is most of the damage associated with a few extreme events or is it the result of persistent exposure even at a low level? Is the concept of mathematical expectation applicable here or must we give attention to higher moments of the probability distribution of events? The answers to these questions may importantly affect the nature of optimal control policy.

Control Cost in Problem Sheds

Under category II (Control costs using existing technologies), a good deal of information seems to exist, widely scattered in the literature, about individual items of equipment or processes. There isn't much, however, that would help the decision-maker to get a broad grasp of the relative merits of alternative control systems, although system analysis might be able to make good use of existing data. Moreover, there seems to be disagreement about the costs of some rather basic processes—automobile emission controls, for example. When we get to indirect effects and to such matters as "trade-offs" between large-scale control measures like solid waste collection, mass transit, and industrial location, and more conventional methods, information is nil.

An interesting study of control costs in the Nashville area using system concepts is now under way by Azriel Teller. Teller was able to wed his cost figures (which relate only to control *equipment* and therefore may not have encompassed all relevant alternatives) to an atmospheric diffusion model of the Nashville area. This formulation permits him to precast the specific effects on ambient air quality monitor resulting from the control of particular sources and to calculate the associated costs. By this means he is testing the costs of alternative control policies—one which endeavors to distribute control in such a manner as to minimize the costs of achieving a particular air standard and one which applies a uniform cutback rule to all relevant sources. Preliminary results indicate that the uniform cutback rule results in substantially higher costs than the cost-minimizing approach.[22] A similar conclusion has been reached in a major water pollution study.[23] These results suggest that the application of system analysis and optimizing procedures will call into serious question conventional and convenient administrative procedures which rely upon the application of uniform standards of control.

In the matter of particular control procedures, some useful work has been done on the costs of desulfurization of fuel oil. Sulfur dioxide from residual fuel oil combustion is one of the more significant sources of destructive and toxic air pollution. A study by L. S. Gaulstein and others[24] suggests that desulfurization would increase the cost of fuel oil about 8 percent per barrel—roughly equivalent to the cost of removing the sulfur from stack gasses in thermal powerplants. But desulfurization may be the only economically feasible way to remove this major pollutant from certain other emissions, such as household heating plants.[25]

Another major source of sulfur dioxide pollution is burning of coal with high sulfur content. Desulfurization of the coal is not feasible, but it may be possible to shift to low-sulfur coal. Unfortunately, while roughly two-thirds of the coal resources of the nation are low in sulfur, they are predominantly in the West while the demand for coal is largely in the East.[26] Accordingly, assessing the economics of restrictions on the burning of low-sulfur coal in the East Coast problem shed, as has sometimes been proposed, presents a large and difficult problem. It involves not only questions of increased transportation costs and induced substitution of other fuels but also the impact on regional economies, such as those of Appalachia, which are already suffering underemployment. A lesson here is that the costs of control measures can be quite indirect and unfortunately at present some of these indirect effects are most obscure. Of course, relatively "clean" fuels other than low sulfur coal such as natural gas could be substituted. But this raises similar problems of impact on already depressed areas.

Striking illustrations of interdependencies between forms of pollution which can give rise to indirect costs associated with controlling one in terms of problems created by another [27] have occurred at the Volunteer Army Munitions plant at Chattanooga, Tennessee. Wet scrubbers were put on air exhausts in an effort to reduce sulfur dioxide concentration. The scrubbers produce waste water containing large amounts of color-producing material. There is no way of treating these waste waters except by evaporation and incineration. Since these techniques are very costly, the waste waters are discharged and constitute a major source of pollution for the river.[28] While significant interdependencies do not necessarily occur, it is necessary to recognize that when a pollutant is removed from one medium, it does not disappear. Accordingly, sometimes meaningful cost estimates for curbing a pollution problem cannot be obtained unless one looks broadly at the whole waste disposal problem.

Aerojet-General, under contract with California, produced a framework-type study of overall waste management in California [29] which went only a little beyond discussion of some concepts of system analysis. Improved studies of this kind are badly needed in particular regions [30] and one is now being planned for the New York metropolitan region under the auspices of the Regional Plan Association.

Under category III (New Technologies), very little that would aid decision-making in "problem sheds" is presently available. One very suggestive study of the potential of electric automobiles has been published,[31] but it is my impression that the possible economic feasibility of the other possibilities, such as systematic use of battery-driven electric trucks and buses, moving sidewalks, and master gaseous waste collection systems, have not been explored. A study which aims to do so is now getting under way, however.[32]

Health Costs

Although our knowledge of the costs of ill health associated with air pollution is in an even worse state than our knowledge of other costs, something must be said about the matter. This is because, as contrasted with certain other environmental problems such as water pollution, air pollution appears heavily implicated as a major public health problem. While property-value relationships could, in principle, incorporate persons' evaluations of the health costs of residing in certain locations affected by air pollution, in practice neither the layman nor the expert knows enough about the relationship of air pollution to health to make such rational calculation possible in choosing sites.

Trying to provide useful information about the cost associated with disease has been a major problem for economics. However, estimates of some economic impacts of a number of diseases have now been made,[33] and there is a considerable literature discussing the pros and cons of particular methods of measurement. Agreement seems to be developing that the most useful measure so far devised is the present or capitalized value of the gross production lost. No economist presents these measures as a full evaluation of the costs—including the psychic costs—of illness and death, and they are perhaps more useful for comparative purposes than for measuring absolute values.

Even the absolute measures may be of some utility, however,[34] in that they can indicate the minimal cost which society can attach to disease and this may suggest whether expenditures for research and control are far out of line. It is clear that the cost of even some of the less virulent diseases is very high. For example, the following total annual costs have been computed for diseases which may be associated with air pollution:[35]

	Million
Cancer of the respiratory system	$680.0
Chronic bronchitis	159.7
Acute bronchitis	6.2
Common cold	331.0
Pneumonia	490.0
Emphysema	64.0
Asthma	259.0
Total	1,989.0

This sums up to a truly impressive loss—but, of course, far from all of this is attributable to air pollution. On the other hand, these estimates relate only to possible respiratory impacts and some pollutants, such as lead, which may be potentially dangerous to health, do not attack the respiratory system at all.

If we wished to use economic loss calculations in a systematic way for decision-making, we would need to know not only what portion of existing disease costs is due to air pollution, but also how the various categories of cost vary when concentrations and lengths of exposure change. Unfortunately, this is an area in which the capacity of medical science to forecast physiological effects falls short even of our ability to predict economic impacts. I know of no medical scientist willing to define any quantitative relationship between the unwanted ingestion or inhalation of chemical residuals at levels existing in our current environment and the rates and intensities of disease. Until this is possible, economic and other research that could assist decision-making with respect to health impacts will be stymied.

CONCLUSIONS

My general conclusions are as follows:

1. Current estimates of the national cost of air pollution are indefensible and should be abandoned. A modest effort is indicated to provide more reasonable numbers.

2. Studies of benefits and costs in "problem sheds" are scattered and often of low quality. Promising lines of approach for making such estimates are opening up, however, and they should be rapidly and vigorously pursued.

3. Studies of control systems, including interdependencies with solid and liquid waste disposal problems, are badly needed. These are essential if we are to understand the management options available and the costs and gains which attach to them.

4. Efforts to make improved estimates of the costs of ill health or death brought about by air pollution are stymied until more precise and dependable relationships between pollution and disease are defined.

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1. For background on this, see *Gustafson, Reuben G.*, What are the costs to society? In Proceedings National Conference on Air Pollution, 1959, pp. 41–44; and *Hitchcock, Lauren A.*, Role of the chemical engineer in air sanitation. In Pollution and Environmental Health, Chemical Engineering Progress Symposium Series No. 35, Vol. 57 (American Institute of Chemical Engineers, New York, 1961), pp. 21–26.

   At about the same time, *Frank Seamans*, Impact of Air Pollution Control Programs on our Economics and Society . . . Industrial Investments, Taxation, and Community Relations, in Proceedings National Conference on Air Pollution, op. cit., pp. 272–75, estimated the national cost to be $4 billion—another widely quoted figure. This number was obtained by multiplying $65 by the urban population.

   Since these early papers, the $11 billion figure has been quoted dozens of times by public officials and others.

2. See Mellon Institute, The Smoke Investigation, Pittsburgh, Pennsylvania, 1913, and *Schmidt, A. W.*, The Pittsburgh Program in Retrospect: The Economic Evaluation, ASME Paper No. 59, PBC-3, Pittsburgh Bicentennial Conference, Pittsburgh, Pennsylvania, 1959. In a recent paper, Comparative Method for Studying Costs of Air Pollution, Public Health Reports, Vol. 81, No. 6, June 1966, p. 505, *Irving Michelson* and *Boris Tourin* suggest that the $11 billion figure was obtained by this kind of extrapolation of the Pittsburgh data.
3. One study took the $11 billion national figure, deduced that this amounted to about $65 per capita and multiplied that figure by the metropolitan area population to get total economic loss. See Interstate Air Pollution Study, Project Report, Phase II, Part VI, Effects of Air Pollution, St. Louis, April 1966.
4. *Beaver H.* Committee on Air Pollution Report. H.M. Stationery Office, London 1954.
5. *Ridker, Ronald.* Economic costs of air pollution: Studies in measurement. Unpublished manuscript, 1965.
6. But the matter of whether national, State, or metropolitan area control is to be exercised is also in part an economic issue. It has to do with how widespread the damage is and whether it is technically and economically feasible to provide control on a small-area basis.
7. For present purposes, we will presume that there is a meaningful index of pollution, although this assumes away a multitude of problems. In practice the approach outlined can be more readily applied to individual pollutants in specific areas.
8. I would claim this even though a recent publication has called such a figure highly illogical. See Technological Change as It Relates to Air Pollution: A Report to the National Commission on Technology, Automation, and Economic Progress, Division of Air Pollution, U.S. Department of Health, Education, and Welfare, Washington, D.C., October, 1965, p. 13.
9. For an effort to compare the national costs and benefits associated with a (large) change in control, but using basically indefensible benefit figures, see *Edmund K. Faltenmeyer*, We can afford clean air. Fortune, November, 1965.
10. Waste Management and Control, National Academy of Sciences. National Research Council, 1966.
11. The dearth of quantitative information is clearly revealed in a recent book (*Harold Wolozin*, ed., The Economics of Air Pollution, New York, W. W. Norton & Co., 1966) to which the author contributed and which contains virtually no empirical information whatsoever.
12. For reasons of space, the present discussion is limited to urban-type damages. Agricultural damages are estimated at one half billion dollars per year. A few somewhat useful studies of agricultural damage have been made in problem sheds. These are thoroughly reviewed in *Emanuel Landau's*, The Public Control of Air Pollution: A Case Study. Dissertation, American University, 1966. They all focus on direct visible effects and ignore such matters as loss of nutritional value and damaging effects on plant structure and growth. On this point and for some proposals for improvement, see *Harold Wolozin and Emanuel Landau*. Crop damage from sulfur dioxide. J. Farm Economics, 48:394, May 1966, pp. 394–405.
13. *Wohlers, H. C., and Feldstein, M.* Corrosion aspects of air pollution in the San Francisco Bay Area. Exterior paint. Bay Area Air Pollution Control District, Mimeo.
14. *Ridker*, op. cit.
15. For a very recent study of this kind, see *James B. Upham*. Atmospheric corrosion studies in two metropolitan areas. Presented before the Air Pollution Control Association, San Francisco, California, June 20–24, 1966, Mimeo.
16. *Irving Michelson and Boris Tourin*, op. cit.
17. *Medalia, N. Z., and Finkner, A. L.* Community perception of air quality. U.S. Department of Health, Education, and Welfare, Cincinnati, June 1965.

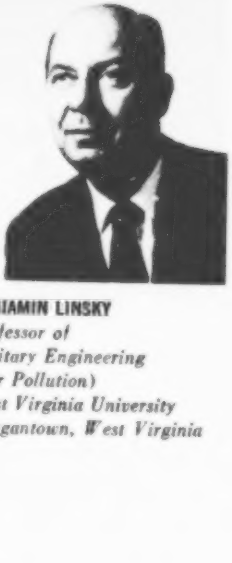
18. A most interesting and apparently successful study to obtain willingness to pay informattion for a recreation area by questionnaire and interview techniques was undertaken by Robert K. Davis. See *Jack Knetsch, and Robert K. Davis*, Comparative methods of recreation evaluation, in *Allan Kneese and Stephen Smith, editors*, Water Research, Baltimore, Johns Hopkins, 1966.
19. *Ridker, Ronald*. Strategies for measuring the cost of air pollution. In The Economics of Air Pollution (Harold Wolozin, editor), New York. W. W. Norton, 1966.

    Robert Strotz has demonstrated that the difference in land value between polluted and non-polluted areas—the magnitude that Ridker's cross section regression study dealt with—appropriately measures the potential welfare gain from a control policy. See *R. H. Strotz*, Use of land rent changes to measure welfare benefits of land improvement, mimeo.
20. *Ridker*, ibid.
21. The variable was based upon the number of months in the 33-month interval from April 1961 to December 1963, in which the fluoride concentration in pasture grasses on the site would have been 40 ppm by weight. Private communication from *Thomas Crocker*, University of Wisconsin, Milwaukee, principal investigator on the project.
22. Reported in a private communication from Professor Teller.
23. Delaware Estuary Comprehensive Study. Report on Alternative Water Quality Improvement Programs by the Federal Water Pollution Control Administration, February 19, 1966.
24. *Gaulstein, L. S.* What does it cost to desulfurize fuel oil? Chemical Engineering Progress, September, 1965.
25. Another study by *Edward Z. Finfer*, Some Technical and Economic Aspects of Residual Fuel Oil Desulfurization, Ind. Hyg., December, 1965, suggests that the process might be considerably less costly.
26. *Walker, F. E. and Hartner, F. E.* Forms of sulfur in U.S. coals. U.S. Government Printing Office, Washington, D.C., 1966.
27. *Richard Frankel* of the RFF staff is just beginning a study which should lead to an improved specification of interdependencies between liquid, gaseous, and solid wastes.
28. Of course, the matter can work the other way around. At the same plant, tremendous amounts of colored waste water are produced in the manufacture of TNT. The waste water is evaporated and incinerated at great expense to control water pollution. The residue is a fly ash containing red dye and a strong odor similar to burnt firecrackers is emitted. The plant thus creates a major air pollution problem. I owe these example to *Richard Frankel*, formerly of the U.S. Army Environmental Hygiene Agency, now on the RFF staff.
29. California Waste Management Study. Aerojet-General Corporation, Azusa, California, August, 1965.
30. An early study which took a broad look at the control problem and made estimates of the costs of control for a mythical westcoast city was reported by *Frank A. Bell*, Costs of Air Pollution Control, address delivered to Industrial Hygiene Section Western Branch, American Public Health Association, Phoenix, Arizona, April 20, 1955. It is not clear how firmly based the cost estimates were and the study did not define relationships between the measures described and levels of control or damage reduction achieved, nor did it shed any light upon the economic trade-offs between alternatives. A somewhat similar study with the same deficiencies was made recently by the National Academy of Sciences for the Delaware River Basin. See Waste Management and Control, Publication 1400, National Academy of Sciences-National Research Council, Washington, D.C., 1966, Appendix 18.
31. *Hoffman, G. A.* Automobiles—today and tomorrow. RAND corporation, RM-2922-FF, November, 1962.
32. Resources for the Future is sponsoring this study by *Robert U. Ayres* of the Hudson Institute.
33. See *Burton A. Weisbrod*, Economics of public health, University of Pennsylvania Press, Philadelphia, 1961; *Herbert E. Klarman*, Syphilis control programs, in *Robert Dorfman, ed.*, Measuring the Benefits of Government Investments, The Brookings Institution, Washington, D.C., 1965; *Ronald Ridker*, Economic costs of air pollution, op. cit.; *J. C. Headley and J. N. Lewis*, The Pesticide Problem: An Economic Approach to Public Policy, Resources for the Future, 1966. The Klarman paper contains useful references to additional works on the economics of health.
34. A recent study illustrates the potential utility of illness and death avoidance benefit estimates even though they are based on a limited concept of benefit. Using benefit calculations analogous to those described above, a Committee estimated the benefits and costs of motor vehicle accident prevention programs. Ratios of discounted benefits and training, to a ratio of more than 1.000 for two programs—increased seat belt use and development of improved restraint systems. The results suggest that expansion of the program and a reallocation of effort should be examined—Dept. of Health, Education, and Welfare, August 1966.
35. *Ridker*, unpublished manuscript, ibid. These include four categories of cost—those due to premature death, morbidity, treatment, and prevention. They are capitalized for the year 1958 at a 5 percent interest rate.

". . . engineer . . . safety engineer in high hazard fires . . . 15 years as air pollution control officer of Detroit and San Francisco Bay Area . . . past president of APCA . . . initiated air pollution reference collection . . ."

DISCUSSION

HOW MUCH IS AIR POLLUTION COSTING US IN THE UNITED STATES?



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Several public-minded specialists in community air pollution control programming have been finding Dr. Kneese's writings on *some* economic aspects of *some* air pollution factors troublesome. Trouble, as used here, is a situation one knows how to deal with, but does not enjoy getting involved in for any of various reasons. (A problem, on the other hand, is a question or situation for which new types of methods need to be developed.)

One major trouble lies in Dr. Kneese's choices of definitions and some occasional shifts in definitions that are not clearly labeled in large enough type, so that some or most non-specialists find they have misunderstood what was really being said.

In the assigned paper "How Much Is Air Pollution Costing Us in the United States?," Dr. Kneese discusses the validity of "$4 to $20 billion dollars air pollution costs per year" as the *national costs to victims of polluted air*. Later in his paper we find that these same costs are called *damage costs* whose *reduction is called benefits* and the term *total costs associated with air pollution* is presented as the sum of damage costs plus control costs. This then is transformed to *national costs associated with air pollution*. The terms *direct losses in economic function, loss incurred to avoid or offset such direct loss*, and *disbenefit*, are presented, as are the paired words *costs* and *gains*. *Economic loss* is also presented for use, as is *health costs*. The terms *esthetic losses, human values, losses of welfare, psychic cost*, and *property values as a surrogate* were also presented, as were terms related to *control costs* in which Dr. Kneese includes *indirect effects* and "*trade-offs*."

The term *damage costs*, used by Dr. Kneese has been for many years limited to "collectable, countable injury as a result of undesirable effects of air pollutants." For example, in vegetation, we speak of vegetation damage only when we mean actual damage. Some injuries, such as to blossoms on home flowers, are not classed as *damage*. A parallel might be a cut on your finger that heals neatly and causes you no lost production nor permanent cosmetic effect. This is called injury, and a malifit, but not damage.

INDIVIDUAL ENTITLEMENT TO UNPOLLUTED AIR

There is missing a fundamental statement of a modern (and very ancient) viewpoint, with which both liberals and conservatives tend to agree, that the undesirable effects of polluted air constitute a *malifit*—the opposite of a benefit—because people in a democracy are entitled to have unpolluted air around them. (Also, anyone who pollutes the air is providing a *private bad* and under most circumstances is also providing a *public bad.*)

These terms are patterned after the work of Professor Albert Breton of the London School of Economics and Political Science, in accordance with the work of Dr. George Denton on the principles of choice and coinage of terms. A check of these terms with Dr. Robert E. Rankin, Professor of Psychology, and Dr. William H. Miernyk, Professor of Economics and Director of the Regional Research Institute, both of West Virginia University, found them in accord with these conceptualizations because the terms "costs," "public goods," "benefits," and "disutilities" did not provide clear enough terms for most people about the undesirable effects and non-renewable resource wastes of air pollutants and air pollution mixtures.

Nonrenewable resource wastes should include scattered minerals, the unused thermal energy from minerals, and the living minutes and hours of people who lose some enjoyment or bodily freedom or are otherwise malifitted by polluted air.

POLLUTED AIR MALIFIT FIGURES

Dr. Kneese discusses the probable usefulness of "the present or capitalized value of the gross production lost", as the *minimal cost* which society can attach to disease, even though he states that this omits *psychic costs.* His presentation goes on to sum up losses, measured as minimal costs for various respiratory diseases, points out they may be associated with air pollution, and points out that even without the non-respiratory-disease pollutants, the sum is almost $2 billion. But—he does not attempt to provide either a psychic factor for pain or a loss of companionship factor. It would be cruel to attribute to Dr. Kneese an endorsement of sudden death for retired people and those who are hopelessly bedridden because they cost the community money to maintain alive in our family of man. Could he not even suggest a figure or an approach?

In this year, 1966, Dr. Kneese's labelling of currently used air pollution malifit dollar equivalents as "guesses" reads almost exactly the way the massive 1915 Chicago Association of Commerce report read in describing the $12 per capita per annum figure estimated in the 1909 Cleveland Chamber of Commerce report.

The fact that even certified public accountants have professional differences about estimates regarding depreciation and obsolescence does not earn them the term "guesses," does it?

Dr. Kneese suggests that we stop using all these estimates at once. I suggest that, instead, we round them off as "more than $15 billion" in order to cover the shifting goals of people and the increased malifit values they are placing upon air pollution effects they formerly accepted. Pittsburgh is one excellent example of an area that cleaned up to the level of an ordinary dirty industrial city, such as Detroit, in the 1940's before their campaign. It was observed that in the early 1960's (even before the current steel-making boom overloaded the air pollution control equipment), some groups of Pittsburgh area citizens were organizing to express their displeasure with what had, 10 years earlier, after their dramatic campaign, been considered by their elders as fully acceptable air.

Some work by Robert Lawyer at West Virginia University has indicated the validity of the concept that people's level of acceptance of air pollutants varies with their earlier history. Those who move from cleaner areas place a higher value on cleaner air. And those who grow up in the current polluted air in some locality visit other areas that are cleaner, returning home with displeasure.

Table 1.—*Estimated cost of air pollution control for gray iron foundry cupola (1959)*

[Size of operation: 48'' I.D. Melting rate—8 tons per hour, 4,000 scfm tuyere air, 4,000 tons net castings per year. Estimated plant investment: $500,000. Castings are worth $350 per ton]

Control equipment or method	Air pollution emission, pounds per hour				Collection efficiency or recovery percent		Cost of air pollution abatement facilities					
	Particulates and droplets		Gases		Particles, 0–5 microns	Gases	Capital investment			Operating cost, per year	Percent of plant investment	Percent cost increase of products
	0–5 microns	>5 microns	Organic	Others			Major equipment	Auxillary equipment	Total			
No control	40	160	30	1,325	0	0	0	0	0	0	0	....
Afterburner	35	140	3	30	0	97	$1,000	$1,000	$2,000	$200	0.4	0.05
Wet cap [1]	35	90	2	25	0	98	10,000	10,000	20,000	[2] 2,200	4	.5
Scrubber [1]	25	15	2	25	30	98	17,500	12,500	[3] 30,000	[2] 4,500	6	.6
Scrubber [4]	10	0.4	1.8	25	65	98	10,000	20,000	30,000	4,500	6	.6
Baghouse [1]	3	0	3	30	92	97	30,000	20,000	[3] 50,000	[2] 5,000	10	1.0
Electrical precipitator [1]	3	0	3	30	92	97	45,000	30,000	75,000	[2] 6,500	15	1.2

[1] Includes afterburners.

[2] Estimated installation costs published by American Foundrymen's Society.

[3] Estimates from similar installations on west coast.

[4] Estimate prepared by Bay area foundry industry.

Another reason for recommending the use of the higher figure until more precise economics-acceptance work is done, is the ripple effect of lost opportunities, supply dislocations, and at least one vicious cycle.

How much did it cost San Carlos businessmen in future business when Varian Associates moved to Palo Alto when they expanded, to escape the pollution of an uncontrolled foundry nearby? How many people had to relocate with their children, from familiar schools and neighbors?

What happened to some of the rubber and plastics producers when their products were displaced as they began to receive increased deterioration from sunburned gases that could be better resisted by other materials?

Has anyone calculated a malifit equivalent of the loss of enjoyment and breeze because he is not able to open a window in New York in the summer due to pollution? This leads people to install filtering air conditioners at some cost, which then overloads the electricity-generating capacities of even the better air-pollution-controlled generating plants and brings less-well controlled units on the line to produce even more pollutants, with loss of non-renewable material resources that supply the minerals for combustion energy. At least once, the air conditioning overload is reported to have tripped off the power to subways which stalled en route for some time in the heat of a warm day.

Has anyone determined the reduction in desirable social interactions, due to air pollution, that keep people, on a lovely, quiet, sunny day, from walking over to visit friends because "why go out into the smog?" Or is the resulting action of watching TV instead an accountable economic gain for the broadcasters and advertisers?

Dr. Kneese cited the paper at the 1958 National Conference by the President of Resources for the Future, Dr. Reuben G. Gustafson, who said they had "made some very rough estimates of the cost," arriving at about $7.5 billion a year. Even though his definitions, his sources of information, and other parts of his presentation were not clear, Dr. Gustafson expressed himself in clear terms, without dollars, about the tremendous "cost of air pollution in terms of how much we suffer from it".

BASIC DIFFERENCES BETWEEN AIR POLLUTION CONTROL AND WATER POLLUTION CONTROL

Dr. Kneese might have given more weight to the significant differences between air pollution control and water pollution control, even though they have some physical connections and some organizational connections with each other and with solid waste control.

A 1958 paper on "Some Air Pollution Aspects of Liquid and Solid Waste Disposal" contained the following points:

1. No one compels you to swim, fish, or put a boat in polluted water. Polluted air, however, comes to you, untreated and largely untreatable.

2. There are a few hundred direct emitters to an area's water body, but there are thousands, hundreds of thousands, or millions of direct emitters to air, as a receiving body.

3. Dilution factors are relatively predictable in water, but are not usefully predictable in air when a large number of emitters are involved.

4. Air polluters usually advertise it in the sky—writing for their competitors, neighbors, and colleagues to learn about.

5. Large numbers of solid waste generators can store their materials for a little while but only a few liquid waste generators and practically no air pollutant sources can do this.

These factors plus the individual's entitlement to unpolluted air are sufficient reasons to relegate Dr. Kneese's controversial concept of cost minimization to oblivion. This concept and the related chart were first brought to my attention when they were presented at a June, 1962, symposium at Ann Arbor by Albert Pasini of the Detroit Edison Company. The concept and chart next appeared at the 1962 National Air Pollution Conference in Washington, presented by Charles A. Bishop, United States Steel Corporation. They were criticized by Victor A. Sussman, Pennsylvania State Division of Air Pollution Control, as to both their internal consistencies (especially weighting) and their validity as a realistic system.

Dr. Kneese should also, I believe, recognize and accept the deterrent value of the unique "disutility" of corporate and personal social stigma from fines and jail sentences as an alternative cost of control. This serves to overcome the reluctance to pay out about $200,000 per year to own and operate $1,000,000 worth of tailend air pollution control equipment—a large number even when it represents a total addition of less than 1 percent to the cost of products.

Citizen-voters and legislative and executive policy-makers both find it useful to be able to observe the added direct costs of products and services due to air pollution control in terms customary to their daily lives.

Thus the Linsky-Tarquinio chart and subsequent calculations show that 6¾ cents a month is the cost of excellent air pollution control in a $9.40 a month average home electricity bill, in a city where the fuel to make that electricity costs about 80 cents a month. In New York, the Consolidated Edison Company has a fuel cost escalation clause which, with coal at $9.55 a ton delivered, provides an average household with 375 kilowatt-hours of electricity for less than $16 a month. If the coal cost were increased by 95.5 cents a ton (or the equivalent in air pollution control equipment) it would add about 16 cents a month to the electricity bill. We all know that this would be a 1 percent increase for an expensive air pollution control change. But we also know that electricity comprises a very small part of our total cost of living.

Similar work has been done on the added cost of excellent air pollution control on a foundry cupola—which adds about 1 percent to the cost of the casting before it is made into a useful end-product—when a reasonably effective collector for the very small dusts, droplets, and combustible gases is provided, as we found in the San Francisco Bay Area.

Dr. Kneese's comments on the uniform cutback rule indicate that he does not wish to recognize the various control regulations that provide for greater effectiveness of control for larger installations based on both the recognized economies of larger scale installations and on the increased malifits from massive single sources. Many localities have used such sliding scale emission regulations for more than a decade.

I hesitate to devote as much attention to the costs of control in this paper as does Dr. Kneese because he seems to have taken a position analogous to the following: "When you are robbed, the robber should not be required to return the money. He should be allowed or encouraged to repeat his theft so long as you do not go on welfare and so long as *he* uses the money more profitably to himself and to the community than *you* would (in his opinion)."

Yet I would be in error if I did not point out that there are three types of "public goods" effects that *can* be examined. The "public goods" I am discussing are the public control agency work and the supporting work of citizens groups who help obtain and carry out studies and corrective enforcement as air pollution control costs. The three effects are:

1. Reduction in malifits of air pollution "victims."

2. Public quasi-ombudsman service by air pollution control agencies where errors of omission or commission by other public agencies are corrected. A classic in Detroit was an illegally-situated factory in violation of zoning laws, that was causing noise and air pollution malifits to apartment dwellers nearby. The plant moved and set up clean and quiet.

3. Improvement and modernization of some private and public processes as a result of being required to give them a high priority of management attention due to air pollution malifits. In view of the more than 20-year average age of process equipment, the opportunities for improvement are not unexpected. One brass melter, in a comfortably profitable market, said that as a direct result of air pollution control code enforcement, he paid for his equipment in less than three years through savings, and was kept from being totally obsolete about five years later.

Each control change, however, shifts several markets and employments and profits for goods and services to meet the changed methods. The need for these many changes in customary relationships in part account for the resistance to change.

The instances of lack of a total engineering economic analysis of the waste material handling from the point of origin to the final resting place are worth retelling to the new people who are entering the field. It was about 1863, I believe, that the British Alkali Act's activities in industrial air pollution control led to one of the early instances of modern massive water pollution, through such lack of sound engineering.

It is interesting to see, again, the idea that master gaseous waste collection systems should be explored, under the misimpression that they never have been. The Given people in Los Angeles and Dr. Morris Neiburger, the meteorologist, have covered this ground repeatedly. The power costs for moving massive tonnages, and the question of whether the master outlet should be near your house or near mine are underestimated.

Of Dr. Kneese's four general conclusions, it must be said that they add up to "Stop doing or using any present information as a basis for real action now. Improve your studies."

I would say:

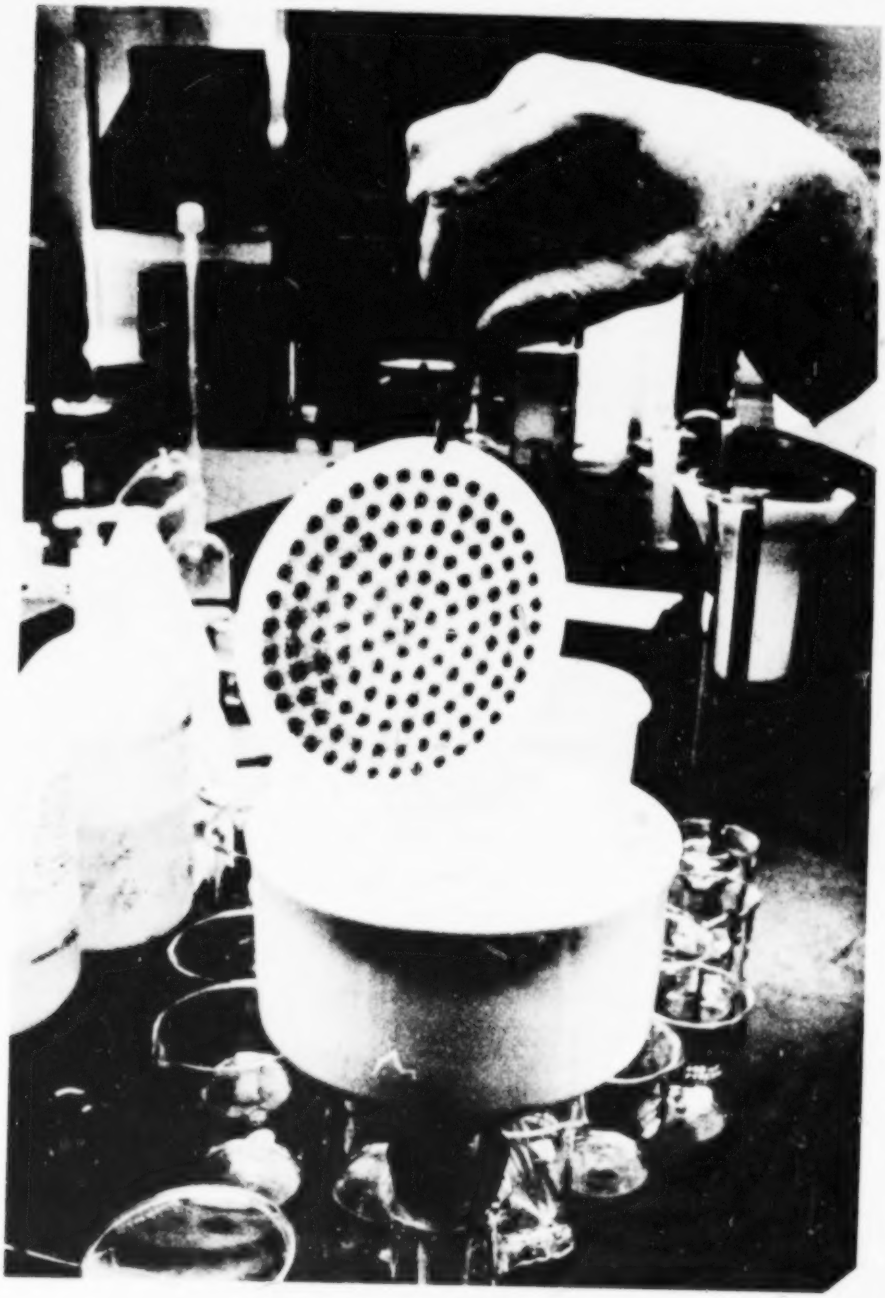
1. Use the current estimates of costs of air pollution malifits until it seems worthwhile to allocate effort for improvements.

2. "Problem sheds" which are not limited to air-sheds, because of spill-over sources and victims, have varying needs for studies of malifits and control costs, depending on the nature of their problems and programs.

3. More reports of studies already done by agencies, by private managements, and by consultants and equipment suppliers should be published in an authoritative way.

using anonymous case history designations where needed, describing the interrelationships between air, liquid, and solid wastes. I have been urging this type of publication for at least 8 years after following the practice of educating others in total engineering economic analysis of the waste materials handling it as a control agency chief in Detroit in the early 1950's.

4. I recommend that additional information and systems of information be developed on the malifits of non-ease without waiting for all the disease relationships to be established to Dr. Kneese's undefined degree of precision and dependability. The information should, of course, be presented in forms that are meaningful to nonspecialist readers. Percent added to product or services costs to correct malifits is more meaningful than the large size of a stack of dollars, which Darrell Huff names "Gee-Whiz" figures.



". . . economist . . . former professor in Kansas, Minnesota, Maryland . . . special interest in small business, conservation, and natural resources . . ."

HOW IS AIR POLLUTION AFFECTING ESTHETIC VALUES IN THE UNITED STATES?

SPENCER M. SMITH, Ph. D.
Executive Secretary,
Citizens Committee on
Natural Resources
Washington, D.C.

Air pollution may affect esthetic values very seriously, but seldom do people rise up and "smite the dragon" in protection of esthetic values.

The question as to how air pollution affects esthetic values in the United States may appear rhetorical. Presumably, air pollution is not consistent with esthetic enjoyment of parks, streams, natural or scenic beauty of any type. As a consequence, the prevalence of air pollution would affect adversely almost any esthetic value whenever and wherever it occurred. It is a strong temptation to say at this point that the question is answered and further commentary is simply an exercise in tautology.

The difficulty with the answer is that it gives rise to many questions—all pertinent and all much more difficult. Are esthetic values presently affected so seriously that public policy is demanded to rectify such conditions? Are processes that give rise to pollution more or less important than the esthetic values that they affect? I say, in all candor, the answer is "no" in both instances.

I would say also that if the tone of this paper in general is pessimistic, it is because I am pessimistic. In our political-economic society this has been the general pattern: We usually have awaited disaster. Then we have reacted to that disaster and taken action costing ten times as much as appropriate pre-planning would have cost.

These are the questions: Is a disaster imminent? Is it likely to occur? Will it involve health, esthetic values, the total welfare of the entire community? All the answers are probably "yes."

Social scientists and conservationists have been down this road before. The problems posed by air pollution have much in common with a wide range of problems involving a variety of natural resources. I would emphasize what Professor Linsky said, that in many respects the problem of air as a natural resource is one of the most subtle and most difficult. While technical problems are always important, the social and economic adjustments required by an effective program probably cause the greatest difficulty.

Professor Linsky may not have been aware of the astonished reaction to his remarks to the Thirty-first North American Wildlife and Natural Resources Conference on March 14, 1966, when he said, "If you have gained an impression that air pollution problems and troubles are recent, and that air pollution control engineering, science and technology are new, you have been misled. Air pollution control engineering was developed in 1863 when the British enacted the Alkali Act." He also pointed out that the massive studies that took place in Chicago and San Francisco in 1915 essentially established the basic air pollution control engineering tools.

The Conservation Foundation, in a study in 1963, stated, "Air pollution is now a political and social problem far more than a scientific one." The Foundation in a letter of July 15, 1966 reaffirms this position.

As one who has been present through many a hearing before the Congress on the subject of air pollution and has heard the steady drumfire of . . . . "We need much more research. . . ." "We cannot determine the ultimate effects until further studies are undertaken, etc.," this is indeed a revelation.

The implication of most of the pleas of inadequate information is that the state of the art is inadequate to provide the techniques that an effective program of air pollution prevention would require. Actually, it is quite possible that studies have not been undertaken, even though the techniques are available.

Why is the problem of affecting appropriate public policy for natural resources, of which clean air is a part, so difficult to evolve? From the very inception of the United States as a government, the emphasis on natural resources has been one of development. The attitudes as manifested in its institutions, whether legal or philosophical, have reinforced the concept of utilizing nature's bounty for the production of goods and services. The first and foremost challenge to a new country was to accelerate and facilitate the ability of the individual to bring land and resources into production. The Homestead Act, the Hard Rock Mining Act of the late 1870's, and the Taylor Grazing Act of about the same period, were examples of stimulating the individual's incentive to the call of development.

Physical labor was needed in abundance. Drudgery was great and hours long. This alone restrained individual political action and physical mobility. The standard of living was both a cause and a result.

From the very inception of the United States the decision as to the allocation of resources to the ultimate use, as well as the distribution of the finished products, was left to individuals, and later to private organizations. The right of private property carried with it a mandate from society to direct such private property with a minimum of interference and to use its gains in the same fashion. Some problems resulting from this system did receive early treatment, such as child labor, certain public health matters, and minimum working standards. In each of these areas, however, the adverse conditions were discernible and were judged sufficiently important to interfere with the system. This resulted in remedial action.

There were and are some basic differences in establishing public policy to deal with natural resources. First, the problem of natural resource management is in identifying the public interest and determining how it is affected. The disastrous effects of bad resource management and misuse, however, often are not immediately obvious. The social burden and the real costs develop years later.

Second, once the problem is identified, most remedial programs strike at the heart of the operation of commercial enterprise.

It has been only recently that our great abilities to translate our natural resources into goods and services have been recognized as creating the circumstances that affect adversely the health and well-being of the community.

It is hard and difficult for a society to understand that it suffers the sins of its virtues. Professor Galbraith observed recently that one caught in the midtown traffic jam in the squalor of a ghetto neighborhood, breathing foul air after having spent the day on a meager water ration, is not overly comforted by the knowledge that the gross national product increased by 9½ percent last year.

The most helpful efforts in this task of digesting properly our abundance have been those of Presidents Kennedy and Johnson, who have urged national attention to the quality of our environment.

Up to this time, we were concerned primarily with increasing the gross national product by a certain percentage. Growth became practically a tocsin to every economist. If he did not have a book or an article on the growth of the economy there was something wrong with him.

We are still interested in the growth and consumption of goods and services but the entire quality and substance of that growth have become important.

The enormous increase of our economic production and distribution has brought us to a new philosophical and methodological attitude. In the process of creating goods and services, we have developed consummate skills of measurement. Such refined tools allow us to quantify our judgments to yield a high degree of reliability. We can measure profit, loss, revenue and costs with great accuracy.

Unfortunately, this highly developed state of the art is not helpful in ascertaining the total effect of air pollution. Once the determination is made as to what a firm must do in order to meet the necessary requirements to prevent air pollution, the result is immediately translatable into economic terms. The increase in cost and the reduction in the profit margin can be programmed with considerable accuracy by business management. The contrary is not true. Much of the discussion today seeks to estimate what the cost of the burdens is on the other side. I have great sympathy with Professor Kneese in trying to establish some basis upon which the social costs of air pollution can be accounted accurately.

No one can establish at the present time the scale and quantification of the improvement of a view or the increased value of a recreation area, or the general quality of an environment as the result of a firm's incurring additional costs to prevent air pollution. This lack of quantification to determine the enhanced value of an atmosphere free from pollution has plagued those who have been seeking a clean air program.

The problem has now become discernible to most conservationists. The question of the placement of a road and the resulting sacrifice of park and scenic values or the construction of a dam with similar results are cases in point. In most instances, construction can be gauged in terms of tons of concrete, amount of traffic, number of kilowatts, number of jobs, increased tax base, etc. These are questions which can be resolved on a thoroughly quantified basis. On the other hand, such arguments as, "This place is a pretty park." "It's a nice area." "Children come to play." . . . seem puny by comparison. How do you write this down in the cold accounting ledger?

In the problem of water pollution, we have been hard at work for more than a decade and can testify to the difficulties and pitfalls that have plagued every step of legislative accomplishment. Responsible resource policy should have motivated action much earlier. If this had been the case, both public and private expense would have been lessened greatly.

Time and again, however, the cost was viewed as the burden upon the polluter rather than that upon the public at large. The total public anti-pollution budgets were usually of such gigantic proportion that immediate public acceptance was impossible.

Ironic as it may seem, one of the significant difficulties of effecting policies for clean water was the advancement in technology itself. The attitude was that irrespective of how polluted the water became, the genius of science would make it suitable for human consumption.

Conservationists in the early days who were urging water pollution control programs for esthetic reasons were thought of as idealistic crackpots, especially by those who took the hard pragmatic line in dealing with public budgets. The knowledge that people could drink without ill effects water in which fish could not live was somewhat surprising, but was dismissed as a nicety that could not be a factor in policy determination at that time.

The usefulness of water for public recreation was not a matter of primary consideration in the early study and discussion of water pollution programs. Public health was well understood by the community, but esthetic values had to await public awareness that in turn depended upon public contact.

Not too long ago, in a nearby metropolitan area, the courts ruled that while public health standards were specific as to the cleanliness of cocktail glasses, the law was silent as to lipstick marks on the glasses. The tests had proved that, though the lipstick mark was evident, it was also sterile. The law being satisfied, therefore, the management could go free. Irrespective of the court ruling, however, the manager indicated that his business had gone bankrupt because of the publicity. The manager was at a loss to explain this circumstance, having just been freed by due process of law. A newspaper man told him it was a matter of "esthetics," to which he remarked, "whatever that is!"

We often find ourselves in not too different a situation, in which certain circumstances have to be established and settled first, before we have time in our public policies to turn to esthetics.

After World War II more people had more money, better means of transportation, shorter working hours, and as a result, travelled more extensively to outdoor recreation areas. It was after this contact that people began to protest the pollution of streams. It mattered not that the water was sufficiently potable, after treatment, to be placed in the water line of the city. Swimming, boating and fishing had in some cases become impossible. It was not necessary to be able to give a categoric definition of "esthetic" damage to realize that a serious diminution in pleasure had taken place. It was at this point that the esthetics of water pollution became a political force.

The economic and political climate in which we attempt to solve air pollution problems indicates clearly that greater complications are involved than in many of the foregoing cases. Its identification is difficult and the total impact is even more difficult to measure. The problem of asking commercial enterprise to incur significant costs in reducing air pollution is fraught with essentially the same difficulties.

The first concern has been that of health, and pollution control was often related only to health. Perhaps the extent of air pollution must increase before serious consideration will be given to esthetic values. The damage that foul and polluted air can do to an otherwise beautiful scene of nature will have to be experienced by a sufficient number of people before serious consideration is given.

The context of the experience is also important. Though people are concerned with polluted air in their urban environment, they often become calloused to the fact, and assume with Job-like patience that this is but another price one must pay to live in an environment of prosperity.

One of the reasons for venturing into the country on a weekend is to breathe the good clean air. If the air is not essentially different from that of the city and the visit is marred by a threatening cloud over a park or seashore, the total recreation experience has been debilitated significantly and the public reaction is one of disapproval. When a sufficient number of people have been discomfited a sufficient number of times a public move to action becomes apparent.

As more knowledge becomes available and the layman becomes better informed as to both the cause and the extent of air pollution, he is faced with the necessity of action. What action and how effective it may be, will depend on how the public assesses the need.

How important are both health and esthetics concerns? All of these questions are answered sooner or later in terms of the budgets at the local, State and Federal levels. It doesn't matter how many programs of air pollution exist and whether at the State or Federal level, the acid test is the budget. How much is a community willing to spend? How strict will the laws be? Unfortunately, there is an additional complication to these readily understood problems, and that is the cultural lag that persists regarding private and public debt. A curious attitude continues to view any dollar spent publicly as sinful and a dollar spent privately as virtuous. There appears to be a rejection of any suggestion that both public and private expenditures can be useful and productive, or that both can be wasteful and unproductive, depending upon the merits of the specific case. This attitude adds to the frustration of attaining an adequate public investment in an effective air pollution prevention program.

Almost any frivolity of private expenditure is permitted on the grounds that to interfere significantly would be a breach of the individual's freedom. It does little good but it is interesting that eight years ago we spent more on hula hoops than we did on the entire air pollution control programs of local, State and Federal governments.

The private economic sector has great advantages. At some point, therefore, the problem must be so grievous, so deleterious to health, so dampening to the spirit and so incongruous with esthetic value that people demand that something be done about it. How bad must the condition become before the hurdle of proper funding for public programs is cleared?

The problem of identification is difficult, as is implementing the plan of action. The difficulty is manifested in public attitudes. Also, quite often, institutions and structural organizations to cope with these problems are not in existence. We may have technical tools to provide answers, but we do not have them in a framework that is readily understood.

One should not be unduly critical of a business which may have been applauded by the community for great enterprise and imagination at the time the physical plant was constructed. It is difficult for the businessman to understand how the same plant has changed him from an imaginative entrepreneur to a polluter of the atmosphere. In most instances, he feels the onus of this responsibility for pollution to be unfair. In most instances, he will react in a fashion to protect the economic position of his enterprise.

His tools are readily available for this undertaking. Most businessmen have had previous experience in these situations and they know how to handle them. His warning to the community of possible bankruptcy if he is forced to finance, from the wherewithal of his company, the total cost of air pollution prevention techniques does not fall on deaf ears. The community, ever eager for economic development to broaden the tax base and provide for the general economic well being, is apt to take up the cudgels in behalf of the firm.

The relationship between the levels of government in dealing with a policy to reduce air pollution is often tenuous, specifically, because public policy must traverse the emotion-arousing barrier of States' rights. Much can be said for the eagerness of citizens to keep controls close to the activities of the people affected. Unfortunately, in this and many similar problems, the choice is too often ineffective and inadequate control or Federal control.

Certainly, the nature of the problem is no respecter of State boundaries. The ability of the States to affect a viable public policy in pollution-prevention is limited. Few States were ever established with an eye to economic self-sufficiency, and most State governments are beleaguered by limited fi-

ENTITLEMENT
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Linsky
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nancial ability. Many are extended to their legal limit of bonded indebtedness, others are frustrated at the high rate of interest. Where the problems are the greatest, the States' ability to achieve effective policies may be the least.

Effective policies have a significant impact upon the willingness of the States to pursue vigorous enforcement action. The location of new industry will depend partly upon State laws that impose restrictions. If enforcement in a State is too vigorous, the State may find that it is losing a major economic unit to another State that has not legislated highly restrictive programs or at least has not enforced rigidly such programs.

In order to effect a vigorous anti-pollution prevention program, the role of the State is limited, though its political role is significant. As a result, most programs are evolved over long periods of time and depend upon much trial and error before established programs become effective.

If the cultural and structural elements in our society have been belabored unduly as not being conducive to esthetic values, either as primary or as secondary goals, then the thrust of these remarks has been misdirected. In reasoning from the general problem of establishing natural resource policy, it appears inherent in any such policy that some restriction must be placed upon individuals.

History is replete with evidence to show that the establishment and implementation of an air pollution control program is a long and arduous task. It should not be suggested that establishing public awareness and implementing programs are two separate and distinct steps, for both must continue concomitantly.

Though two Clean Air Acts have been passed in the past two years, the most ardent proponents of the legislation would not contend that they are much more than good beginnings. It is much too early to suggest the extent to which esthetic values will be enhanced by programs of air polution prevention.

The effect of air pollution on health, which is usually the first concern of the community, has yet to be appreciated fully. The fate of esthetic values will depend on the extent and severity air pollution is allowed to reach before effective action is taken. If our present pace of air pollution prevention is an augury for the future, then present conditions will worsen considerably before any effective improvement is evident.

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DISCUSSION

HOW IS AIR POLLUTION AFFECTING ESTHETIC VALUES IN THE UNITED STATES?

MRS. B. BRAND KONHEIM
President,
Citizens for Clean Air
New York City

Since the preceding speaker looked at the broad spectrum of social consequences of air pollution, I would like to look almost exclusively at air pollution as an esthetic problem, for I believe that no aspect of dirty air so motivates public anger as its assault on the senses.

The American public has reached a new threshold of awareness of its environment. Accompanying the new social expectations in economic betterment and human rights is the expectation of living in an esthetically pleasing world.

Washington, D.C. and every State capital are becoming aware of the political force of natural beauty. Perhaps no aspect of the First Lady's activities endear her to the American public so much as her encouragement of natural beauty.

Pristine air and water, bright and fragrant flowers, the shade of leafy trees are the elusive cravings of the urban dweller as he attempts to enjoy his open air in gray concrete enclaves, beflowered by plastic plants whose grimy surfaces indicate that even they are not much more immune to polluted air than the withered shrubs they replaced.

The "culture boom" has made increasing numbers of Americans aware of the art treasures they have inherited from other continents and other times, and of the few architectural gems of our own landscape; and they are being provoked to a desperate anger by the gradual, but all too visible, destruction of these relics. How real is this threat of air pollution to all these esthetic factors?

One hardly needs to raise the question of the effect of polluted air on our buildings. Blackened buildings have made exterior cleaning by the more affluent landlords a major industry in New York, with an income which about equals the budget of the city's Department of Air Pollution Control.

The entire marble facade of the eighteenth-century New York City Hall had to be replaced at a cost of $1,000,000.

St. Patrick's Cathedral has had much of its limestone replaced. The brownstone of our townhouses is flaking away. And the *New York Times* now reports that the marble ornamentation of one of our leading hospitals "crumbles between the fingers like a cube of sugar."

This disintegration is a major concern of the curators charged with the preservation of the monuments of western art. In order to protect the ancient stone structures at The Cloisters, the medieval branch of the Metropolitan Museum of Art, wax coatings and other impregnations have been used for years. "Cleopatra's needle" behind the Metropolitan has undergone more erosion in less than a hundred years, in New York City than in its 2,000 years in the Egyptian desert. One can see the complete erasure of the hieroglyphics on the side of the obelisk most exposed to the prevailing winds. This dramatically demonstrates the corrosive effects of the combination of sulfur dioxide and moisture in the city's air. Sulfuric acid has etched away the stone of the obelisk just as it etches glass.

The administrator of the Metropolitan Museum of Art has said that, "Our responsibility in maintaining a great art treasure house is to preserve the objects we have brought here. It is pointless to collect outstanding works of art, many a thousand years of age, if a thousand years from now they are going to be so badly deteriorated as to be virtually worthless."

Even the protection of books and manuscripts exposed to urban air has become a major part of library science. The new library of the Metropolitan Museum alone uses $12,000 worth of carbon air filters a year.

Let us consider the effect of polluted air on the greenery which gives such visual relief in an urban landscape. City dwellers have become accustomed to seeing withered trees at bus stops, while more distant trees seem to prosper. But then not all other trees do prosper. New York's Parks Commissioner recently reported to us that Central Park was originally landscaped with 150 varieties of evergreen trees, to provide a pleasing winter drive. Only one scraggly variety remains. Young trees planted along side streets in attempts at beautification fight enormous odds in reaching maturity.

Plant breeders seem unable to develop many strains which are less susceptible to pollutants. Flowers have to contend not only with injurious gases, but with an estimated 25 percent less sunlight in New York than elsewhere. Everywhere the city succumbs to plastic plants, cheating the onlooker of the very bit of nature he seeks.

And how does air pollution affect how people live? One economist for Consumers Union found that the standards of cleanliness of people in a dirty city soon lower. For example, people tend to clean curtains only once every three months. "In a dirty city," he reported, "they were clean only one week and dirty eleven weeks." And he said they looked awful. Housewives give up on window sills which never stay clean; children get used to looking out of grayed windows; men get used to driving gritty cars.

Gray dingy surroundings certainly affect how people feel. The grit and grime assail the sense of touch. The ubiquitous odors destroy the sense of smell. The general gray, the decreased sunlight create a kind of "rainy-day-syndrome," affecting our spirit. People approaching the city are even denied the majesty of the skyline as it is increasingly blotted out by a smog blanket.

Public opinion surveys indicate that dirty air is second only to poor public schools as a factor which drives young middle income people from our urban centers.

The idea that more people are motivated by this kind of visceral reaction than by health hazards or costs of pollution is reinforced by the responses to the recent advertising campaign of the organization I represent, Citizens for Clean Air. Listen to some of these letters:

> "Air pollution is hazardous, to say nothing of what this grime and soot shower does to my morale."
>
> "Isn't it peculiar how New York City has a brown sky instead of a blue one?"
>
> "We are forced to keep our windows closed day and night and use a perfumed air spray to mask the odors."
>
> "My family has decided we can't take this dingy city any longer. We're moving."

Esthetic considerations, however, are rarely the factors which motivate the experts, the engineers, and the professional control officials. But I contend they are what motivate citizens.

The fight for cleaner air is not being led by asthmatics or the victims of emphysema, or by those people of marginal health who first feel the effects of pollution. It is not even being led in most cases by the members of the medical community. It is being led in most areas by healthy, young articulate people who have decided that they need not and will not tolerate this assault on their senses. They have not come to New York to sit in sidewalk cafes, only to be served "fly ash cocktails."

Will this type of citizen involvement hasten the control of pollution? An official of the National Center for Air Pollution Control of the Department of Health, Education and Welfare has said: "You have to have a public aroused enough to convince the politicians it's something they must act on. These two elements, the people and the politicians, are the basis for any effective program. You can't compel industry to do anything unless it's convinced it's defying public opinion if it doesn't go along."

The latest *New York Times* series on air pollution concluded, "This will not be a matter which, like water pollution, the public can leave largely to the experts."

Then what do citizens do? They create a climate of opinion to which the leaders of government and industry must respond. They create a demand for clean air, born out of the spreading conviction that air pollution is not an immutable condition of modern life; that the technology now exists for cleaning up our air; and that in spite of the cost of putting that technology to work, clean air is going to cost far less in out of pocket expenses than dirty air.

How do citizens foster that conviction? We feel that they must educate. Citizens for Clean Air does it through a Speakers Bureau; by holding special briefing sessions for affiliate organizations; by circulating a newsletter; and by presenting television and radio forums. We hold monthly technical workshops. We testify at legislative and administrative hearings. We issue statements to the press. We urge public agencies, utilities and industries onto new paths toward clean air. And, due to the generosity of a singularly enlightened advertising agency, we had an advertising campaign. This advertising campaign is just the beginning of mobilizing the entire business community in New York.

Our activities are carried on with a miniscule budget and by a host of volunteers who donate their time and talents. This kind of enthusiasm can and must be generated wherever the quality of air is threatened.

We believe an aroused citizenry is the basic ingredient for the success of control action everywhere. This has been most dramatically true in California; it is becoming true in New York. It can be true in your community, too.

If the forces of air pollution are blighting your community, destroying its beauty and draining its spirit, you already have the ammunition to begin a successful campaign to arouse your public. And in doing so you will have taken your first indispensable step toward cleaner air.

How is air pollution affecting esthetic values in the United States? We believe polluted air so directly affronts the growing national desire for beauty and quality in our lives that this, if nothing else, will act as the impetus for effective control.

". . . planner with Urban Renewal Administration . . . formerly consultant in city planning . . . lecturer on urban renewal at Harvard . . ."

PLANNING AND ZONING—CAN THEY BE MADE TO WORK FOR CLEAN AIR?

DORN C. McGRATH
Director,
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Department of
Housing and Urban
Development
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City planners have long been concerned with the problems of air pollution. Every basic text used in academic curricula in planning contains a chart showing how to locate smoke-producing industries relative to the prevailing winds in a community, and always indicating that smoke-sensitive uses, particularly residential uses, are off-limits in the downwind quadrant.

I need not tell you that this level of consideration in the planning curriculum is no longer adequate. We know how to abate smoke nuisances; the successful programs in St. Louis and Pittsburgh, and the declining percentage of soot and other particulate matter contained in smoke have made this possible.

The air pollution problem of today is much more complex, requiring a much higher degree of sophistication in successful abatement efforts.

The Spilhaus Committee on Pollution of the National Academy of Sciences—National Research Council reports that carbon monoxide constitutes 52 percent of the 125 million tons per year total pollutant load in the atmosphere in the United States, and that transportation is the source of nearly 60 percent of that 125 million tons. All told, internal combustion-powered transportation contributes the largest part of the pollutants—carbon monoxide, oxides of nitrogen, and hydrocarbons, which in the aggregate amount to 88 million tons per year, or 70 percent of the total. These figures suggest, indeed demand, that any effort to reduce the level of air pollution in the United States should focus heavily, though perhaps not exclusively, on the internal combustion engine.

I should mention, too, that the internal combustion engine in the automobile becomes the object of immediate remedial treatment in the context of reducing not only air pollution levels, but also congestion levels in the cities. There is broad concern in the United States for discovering more satisfactory ways of living with the paradox of the automobile as (1) a necessity of modern urban life; and (2) as a direct threat to the quality of modern urban environment.

It is not my purpose here to provide a prescription for every metropolitan area. We recognize that in problems of air pollution as in problems of urban land development, urban transportation, metropolitan public facilities, and the whole range of concerns for a metropolitan planning agency, each area is different; each area has its own special considerations. For that reason, I would like to discuss today what we might call the air pollution component of the metropolitan planning process.

I would like to suggest its general dimensions, what it should include, what its objectives should be, and the kind of institutional arrangements that will be necessary to carry out the findings and recommendations of such a component.

METROPOLITAN PLANNING—ITS AIR POLLUTION COMPONENT

I should express a debt to the Northeastern Illinois Planning Commission, which often is referred to as NIPCEE. It is the only official metropolitan planning body to which the Department of Housing and Urban Development is providing support under its urban planning assistance program, for air pollution studies as an actual element of comprehensive metropolitan planning. NIPCEE calls this their "air resource management study."

The air resource management study, though organized within the basic structure of the Northeastern Illinois Planning Commission, represents an undertaking involving a cooperative effort with a number of other agencies, including the City of Chicago, Cook County, the State of Illinois, and the U.S. Public Health Service. Data are being supplied by all of these bodies, and the Public Health Service has detailed one of its officers to the Commission to work on the study.

This study is especially significant in that it involves an immense and complex metropolitan area. It involves a bi-state area, and begins to approach the problem of air pollution at the metropolitan scale as one of the undebatably metropolitan planning problems.

We feel that the Northeastern Illinois Planning Commission program can well serve as a prototype for similar kinds of undertakings in other metropolitan areas in the country. I should hasten to add, however, that although the study is nearing completion, its results have not yet been reported and a final comprehensive report has not yet been issued. It is therefore impossible for me to report to you all of their discoveries and the conclusions, and I will therefore confine my remarks as to how they went about the study and what they expect to learn from it.

As in the case of most planning studies, it was necessary to begin by gathering certain basic data about the existing situation. For this reason, the air resource management study developed an air sampling network to define patterns of pollution throughout the metropolitan area for suspended particulate matter, sulfur dioxide, and other pollutants. At the same time, it sought to identify the major sources of pollution, and develop an inventory of methods of controlling pollutant emissions at the source.

The significant departure for the Northeastern Illinois program came in its attempt to bring together consideration of the pollutant levels and sources of pollution with basic comprehensive planning considerations; with economic and development analyses, land development patterns, transportation networks analysis.

The final result of the air resources management study and the other work of the Commission is to be a comprehensive plan for the development of the metropolitan area, in this case, one which explicitly takes into consideration the intelligence developed concerning air pollution.

This, then, would appear to be the rudimentary basis for an air pollution component in a comprehensive program of metropolitan planning. It would identify the sources and kinds and extent of pollution and then attempt to relate these to the traditional planning considerations concerning the growth, and the physical and social development of the region.

Let me emphasize that in air pollution, as in so many other elements of the planning process, the planning agency cannot work alone. It must rely for data on agencies specifically charged with gathering information about air pollution.

Even more important, the planning agency must rely on yet another agency empowered to control air pollution at its source, an agency empowered to enforce regulations concerning the amount of pollutant emissions which may be permitted from any single source, for the implementation of the planning recommendations. And, of course, where land use and zoning considerations are taken into account, the planning agency must rely on local government, or the units of local government in which the basic zoning authority is vested.

Planning and implementing an air pollution program, therefore, involves institutional arrangements which are at least as complicated as the technical studies on which the program is based.

Each of the involved institutions, the metropolitan planning agency, the air pollution control agency, the general units of government, the city and the county, all have appropriate roles to play in planning and implementing an air pollution control program.

THE LAND USE-AIR POLLUTION EQUATION

Planning for physical development and the control of land uses with respect to air pollution accepts two basic notions. First, it accepts the proposition that the most effective control of air pollution must be at the source. Secondly, it accepts the proposition that there are presently technological and economic constraints and pressures of a high order which work to reduce the effectiveness of controlling pollution at the source. The land use planner must, therefore, recognize that his impact on pollution control will be secondary at best, but he will continue to have an important function, given the current state of the art of pollution source control.

With respect to the primary pollutants, the particulates and other pollutants that do not change in the air and which have a relatively short fallout potential, the goal of planning, other than that of elimination of the pollutants at their source, must be physical separation. This includes identification of the most serious offenders and the development of land use plans which tend to separate these offenders from the most sensitive alternative uses. For the public planner, the greatest implication here is in the location of major public facilities, especially powerplants, and of major industrial uses whose location the public planner can usually affect through zoning controls.

Buffer zones appear to be of limited utility because the kind and size of buffer required for a major powerplant or a major steel fabrication facility would be so large as to be totally unrealistic in the modern metropolitan context. There are also serious questions as to the type of forestation that can survive in some buffer zones.

There are, however, two factors which may serve to maximize the buffer principle as a device for insulating pollution-sensitive land uses from pollution generators.

The first is the tendency of modern industry to seek sites at the fringes of metropolitan areas, where land costs are lower, and where it is possible to locate lower density plants on rather large sites.

This has the effect of providing a substantial amount of open land around some of the new major industrial facilities. It also has the effect of drawing still more vehicles, usually automobiles, to those same sites at the same time. And, of course, there is no way to guarantee that suburban sprawl may not re-embrace the isolated industrial park.

A second factor which works in favor of the creation of larger buffer zones is the availability of new kinds of Federal assistance to local governments for the acquisition of open land. The two major sources are the Open-Space Land Program of the Department of Housing and Urban Development and the Land and Conservation Fund program of the Department of the Interior. Both of these programs provide 50 percent matching grants to State and local governmental bodies for the acquisition of open land. To use such land as an air pollution buffer requires, of course, a very close relationship between planning for public open land and planning for private industrial development. When metropolitan planning agencies have gained more experience in planning for air pollution control, we will be in a better position to evaluate the potential of integrated open space and industrial development planning.

With respect to the secondary pollutants, the problem is a great deal more difficult, because in this case we are talking about pollution generated by the automobile, by space heating in individual homes, and, to a lesser extent, by new industries which generate chemical pollutants and discharge them into the air.

As has been noted, our society is dependent upon the automobile, and until we can create the kind of metropolis which diminishes the need for the use of the private automobile and, in effect, encourages the use of non-polluting mass transit facilities, we must deal with the pollution that the automobile will generate. But, with the working of the new Federal law controlling pollutants emitted from private automobiles, the problem may be alleviated. However, it seems clear that it will not disappear.

LONGER RANGE PROSPECTS

In the long run, prospects for planning to abate air pollution may be brighter.

The increasing concern at the national level, of which this conference is representative, is an indication of the pervasiveness of the problem and its great menace to the health of our people. The frontiers of knowledge must be pushed back, and we must all do what we can to understand the linkage between the polluted air and damage to health. When that fact becomes established, when it is understood that the simple act of breathing may involve the slow taking of one's life, then enough public pressure to do something will be generated. Out of this kind of pressure will come the real solutions to the problem.

There are at least three crucial factors here: (1) research into low pollution-potential vehicles; (2) research directed at a national fuel policy which will have as one of its clear goals the reduction and eventual elimination of air pollution due to the burning of fossil fuels; and (3) research into industry-generated pollutants, and the derivation of economical means of eliminating those pollutants. In each of these areas, we are dealing with subjects which are fundamental to the basic economic and social fabric of our society.

These are, therefore, as no one at this conference needs to be told, extremely difficult questions with which to deal through a comprehensive planning process. They must be considered, nonetheless, and they must be considered explicitly. The role of land-use planning must not be established as a straw-man alternative to these more fundamental considerations.

To answer the question, then, "Planning and zoning: can they work for clean air?" Yes, of course they can, but they must not be oversold; we must not expect too much; their impact will be limited. The need for national action to deal with the problem of air pollution wastes at their source is absolutely critical and fundamental.

I would like to echo some of the pessimism of previous speakers. The question, "Do we really care enough for clean air?" should be kept firmly in mind as we attempt to apply planning and zoning techniques to the metropolitan problem of air pollution. Planning and zoning are fundamentally procedures employed by society to make the business of government, and primarily local units of government, more orderly in response to economic pressures of urban growth. Until enough people to constitute a critical mass of public opinion perceive the gravity of the air pollution problem, it is unlikely that needed remedial action will be taken. When this happens we must remember that neither planning nor zoning, especially zoning, is a very effective remedial procedure. Both can be very effective preventive procedures, however, provided that they have the backing of public commitment.

We shall need more public insistence on planning for the prevention of air pollution by applying available city planning techniques in our comprehensive metropolitan planning processes.

". . . regional economist . . . long associated with Arthur D. Little Co., consultant planners . . ."

DISCUSSION

PLANNING AND ZONING: CAN THEY BE MADE TO WORK FOR CLEAN AIR?

PETER M. STERN
Director of Regional Studies, Tennessee Valley Authority
Knoxville, Tennessee

We concur with Dorn McGrath's thesis that land-use planning and zoning cannot and should not be offered as alternatives to controlling pollution at the source. Given the proper institutional framework, control can best be achieved by applying the proper mix of technology and economic policy so that capital equipment will be substituted for demands on nature—where nature is represented by fossil fuels and the air.

Until these new institutional arrangements become acceptable let us see how flexible planning and zoning, when used in concert with certain economic measures, might contribute to reducing the cost of air pollution control in a metropolitan area.

Traditionally, an industrial district would be designated in a pre-selected location downwind from the major areas of population concentration, and industrial expansion would be confined to that carefully buffered zone. This apparently sensible arrangement breaks down, however, when the buffer zone becomes too valuable a piece of real estate to remain in open space use or when industries are attracted to other parts of the metropolitan area in search of low-cost land or other locational considerations.

Under a more sophisticated system of administration than presently practiced, it might be possible to allow industries greater freedom of locational choice, provided they are willing to bear the cost of pollution abatement. For the fullest realization of public benefits, zoning constraints should be exercised in the form of emission royalties or license fees graduated according to location instead of the traditional exclusion from areas not zoned for industry.

Most communities depend for continued prosperity and expansion upon the attraction and/or the retention of the so-called basic or export industries which generate income flows to the other sectors of the metropolitan area. Export industries are less likely to require central locations than the local service industries and, at the same time, their land requirements are large per unit of value added.

In order to reserve adequate downwind land for such extensive land uses, the community will have to do more than establish a zone for heavy industry. It may have to consider taxing unimproved land in such a zone so as to restrain land speculation and encourage the orderly development of an industrial district whose eventual compactness will facilitate the community's enforcement of performance standards.

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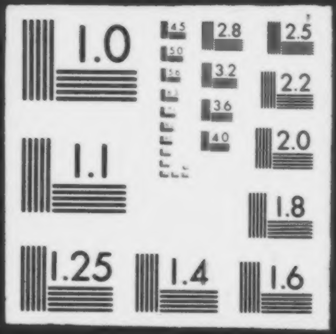
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Eventually, of course, it will become necessary to enlarge the industrial area or to establish new ones involving adjacent political jurisdictions. Until we can agree upon an institutional solution to spread the burden of taxation equitably across the entire metropolitan area, zoning for industry will remain more of a tool for industrial development than for land-use planning and pollution control. And even if such political consolidation should occur, urban growth in the postwar period has demonstrated that "dilution is not the solution to pollution."

Urban sprawl, we have come to know, compounds the problems of controlling air pollution because it increases the distance people must travel, reduces the ability of fixed alignment public transportation to serve the commuting public, and multiplies the difficulties of solid waste disposal.

Air conservation, then, is better served by the containment of urban sprawl and the control of emission by a system of licenses and charges geared to the maximization of social benefits.

In his discussion of primary pollutants, Mr. McGrath advocates a land-use policy which would isolate the chief offenders from the rest of the metropolitan community. The urban planners, in this instance, could perhaps influence the location of such major public facilities as powerplants and also large units of heavy industry. TVA's experience in siting some of the Nation's largest steam plants might throw some light on this proposition.

The locational considerations of thermal powerplants are quite explicit. Since enormous quantities of cooling water are required, the search for a plant site is limited to the shoreline of a substantial body of water. Specific cost functions relating to plant distance from load centers and fuel sources can be readily determined. More difficult, perhaps, is the evaluation of the proposed plant's effect upon the surrounding land uses. Since cooling water is a major factor, TVA's steam plants are typically located on a riverbank or a reservoir shoreline where potential conflicts with industrial, recreational, or residential uses must always be considered ahead of time.

TVA has dealt with the problem of air pollution in two ways: the construction of very high stacks and installation of cyclone-type ash collectors and electrostatic precipitators. While TVA is thus able to control stack emissions to acceptable levels, the search continues at an accelerated pace for an economic solution to the sulfur dioxide problem.

Fortunately, most TVA steam plants are not located in the midst of major population concentrations. With increased utilization of all reservoir shorelines, however, it would be costly indeed to maintain buffer zones around these facilities.

The experience of recent years has proved that some of the land adjacent to strategically located powerplants is sought after by transportation and water-oriented industries, so that an industrial waterfront relatively isolated from other land uses can, in fact, be planned in conjunction with the siting of new steam plants. The key to a successful development here, as in other relatively open areas, is to convince the local unit of government to accept land-use planning and zoning before population pressure and speculation interfere with the most productive utilization of strategic waterfront.

We think that land-use planning and zoning can help control the effects of air pollution, while technical solutions and economic policies are perfected to control emissions at the source. It would appear, however, that this tool can be more effective in nonmetropolitan areas where planning precedes development and where the cost of using open land as a buffer is lower, at least temporarily, than the impact of other policies.

Ideally, land-use controls can work most effectively for clean air when they are also used to shape the form and direction of metropolitan growth.

QUESTIONS AND COMMENTS

RICHARD S. SECLOW (*Vice President, Carl Ally, Inc., New York City*): If you'll forgive the candor of an outsider, I am not in the air pollution business, I am in the advertising business, and it has been our pleasure to work with the Citizens for Clean Air, whom Mrs. Konheim represents. The biggest problem is public apathy. Those of us who worked with the public in New York City find that people, to be blunt, don't give a damn.

We started off our volunteer advertising campaign by introducing something we called New York lungs. One of our pictures showed an x-ray taken at a post mortem at Albert Einstein Medical School. It was, in fact, a bona fide emphysematous lung. Let me quote for you the copy from three of our advertisements. One said: "203,520 tons of dirt fall on the New York area every year, enough to bury a lot of people." "Tomorrow morning," another began, "when you get up, take a nice deep breath; it will make you feel rotten." A third just said: "Your lungs are as grimy as your windowsill." In all of our advertisements, readers were asked to write to Box 1,000,000.

This is a major problem we've had: How do you shake public apathy and get people to protest? Our client, Citizens for Clean Air, is a tax-exempt organization. It is not allowed to thump for legislation. Therefore, we were reduced to asking for a public petition, and that just doesn't work.

We also used some radio commercials in New York City, two 30-second announcements. Since it might prove helpful to others who may want to put on a similar campaign, I'd like you to hear the copy for one of them. It went like this: "Every day, you inhale 15,000 quarts of air, all of it polluted. This polluted air contains sulfur dioxide, a chemical linked with chronic bronchitis; carbon monoxide, which in sufficient quantities will kill you; acrolein, a chemical used in tear gas in World War I; and benzopyrene, which has produced cancer on the skin of mice. Our polluted air also contains unconscionable amounts of dirt and soot. It has come to the point where either you do something about air pollution, or air pollution may do something to you. If you've had your fill of polluted air, send your name and address to Citizens for Clean Air, Box 1,000,000, Grand Central Station, New York."

We have not gotten much mail in response to our campaign, because people aren't going to sign up for things, particularly as a means of expressing complaints. As I said, we have been barred from saying: "Write to your Congressman" or "Call your Commissioner." That won't do any good. What we were trying to do, of course, was to avoid pussyfooting and come directly to the issue of what the game is, and the game is death. That's the way we see it. We're not talking about ruining nylon stockings or getting the chrome on your bumpers all corroded. That's not the problem. The problem is human health, life or death.

If you have found, as we found, that public apathy is a major obstacle, I suggest that you do as we did and get hold of some people who want to do something about it. This campaign of ours has all been volunteers. Every single photograph and word of copy were done by people who were personally, almost violently, interested.

KONHEIM: Every part of this advertising campaign was donated, including media space, agency services, even the services of the actors who acted in the film. I think the attitude of everyone in the advertising agency demonstrates a kind of contagious enthusiasm that this cause is capable of arousing. Practically everything that we have done has been done by volunteers of the highest caliber who have contributed their services. Once you get this kind of program started in your community, you will find that kind of support from people who want to do something and contribute, not necessarily in money, but in the talents which are so much more valuable to you.

What has happened in New York, I think, is that, while there have not been a million people who responded to the advertising campaign, there is now an increased awareness among all New Yorkers, and there is very definitely general discontent with the state of the air. It has recently been very strongly expressed in the press, and I think that apathy in New York among the general public is no longer really a problem.

Incidentally, one of the reasons that apathy exists in many communities is that the citizens feel a sense of hopelessness, that nothing can be done about this problem, that it's part of the condition of urban life that must be accepted. And when you first point out that this is not necessarily true—that there are alternates—you begin to counteract the sense of apathy. It's most effectively done when you begin to point out possible alternatives; this is one of the roles that a citizens' group can play. They may not be technical experts capable of judging which is most feasible, but still, pointing out that alternatives exist captures the public imagination and provides new avenues of support.

SMITH: I, too, know something of the problem of public apathy. Ten years ago I started working for the Citizens' Committee on Natural Resources. The committee decided that we would be non-tax-deductible. And we would file lobbying reports. I won't bore you with the agonies of that ten years of trying to get enough money to keep the doors open, but I can assure you it wasn't easy. At the present time, we do petition Congress. We do say to people on our mailing list: "Write your Congressman." We do have people who write in and say it's an international disgrace to spend less than $40,000,000 a year in the United States (local, State, and Federal) on controlling air pollution. We have been pretty aggressive and we have been pretty militant. We have the scars to show for both.

But I would suggest to you that creating a situation that overcomes public apathy is more than that. It's more than having people jump up and say "Three Cheers and a Tiger! Let's Make War Against Air Pollution." That has to be translated in political terms at the local level, at the State level, and at the national level, where bills are written, where controls are made, where money is appropriated. Until citizens' organizations get to the place where they believe so deeply in this matter that they're willing to petition their Congressman and let him know that he will not have their votes unless he does something about these problems, adequate legislation will not be passed. The only way effective and well financed programs can be achieved is through an aroused citizenry that petitions a Congressman with real forthrightness.

LINSKY: I would like to encourage those who are doing citizens' work by informing them of a ratio which I call the second law of semisocial physics, which is recognized by political and by public relations experts. For every 10,000 people that are sufficiently disturbed about a community problem to talk to their friends, their neighbors, their families, and their workmates about it, fewer than ten will look up a telephone number and call somebody that might possibly do something about it, and not more than one will write a letter, address the envelope, and put a stamp on it, and mail it. And so the very small number of countable responses is recognized by those who are astute in the art of political possibilities as indicative of a far larger number who may have been favorably influenced by the campaign—and may even vote accordingly some day—but won't take the trouble of responding.

HENRY C. WOHLERS (*Associate Professor of Environmental Science, Drexel Institute of Technology, Philadelphia*): I disagree with Dr. Kneese's earlier comments on two major points. The first is that I've gone through the literature and studied the sources from which most of the economic data come. While I agree that more accuracy is needed, I believe that the $12 billion figure for nonmedical expenses is reasonable—probably low, but certainly reasonable. My second criticism is that one other important economic factor should also be considered in connection with the cost of air pollution.

A second figure which I would like to see developed is the cost of controlling air pollution emissions to a desirable level. If this cost approximates the cost of $12 billion, I see no alternative but to get on with the control job as soon as we can.

Both my points can be substantiated with the results of Michelson and Tourin (Public Health Reports, June 1966), who showed that the economic costs of air pollution effects in a "dirty" city were $84 per capita higher than similar costs in a "clean" city. Costs did not include medical or esthetic effects. The $84 per capita figure is considerably higher than the $65 figure on which a $12 billion annual loss was based.

KNEESE: Let me respond to that. It may be that Dr. Wohlers is aware of some literature that I am not aware of. This is quite possible. I did make an effort to search fairly carefully into the sources of this particular calculation. Let it be clear, however, that I did not imply, in any sense, that the $11 billion figure was necessarily too low. I just said it was wrong.

There has been some impression left, by one or two of the speakers, that the economist is interested only in those things that are true market transactions in which one can readily count a number of dollars that have been spent. But this is not the case. This is not the orientation of economics as a social science. Much of the effort that has gone into the evaluation of damages from air pollution has been an effort to evaluate those things that are not exchanged in markets. For example, esthetic damages, which have been mentioned earlier, which are a simple kind of dissatisfaction with one's environment which is discovered and evaluated through interview studies.

Efforts have been made to get this kind of evaluation through property-value studies. I am not promoting these as being fully developed and defensible in all respects, but I think they are well oriented and they are careful. If it is correct that the $11-billion figure originated as I was informed it did, then I don't see how anyone could defend it, because it simply is not information. If it was, in fact, based on the 1913 study in Pittsburgh, which involved a pollutant of a very different kind than those which are now the most prominent and causing the heaviest damages, and has now been applied to the entire United States population including those who live in Muleshoe, Texas, as I believe it has been, then I do not believe anyone can claim that it is a good estimate.

Moreover, it doesn't include some very important things that are, in fact, nonmedical costs of air pollution, the esthetic damages that we were discussing a while ago, the simple human dissatisfactions that are associated with having air that does not meet certain esthetic standards of the person exposed to it.

I think there are possibilities of making some progress toward including this kind of thing and what I was doing was outlining what I thought was an approach that could be implemented over a fairly short period of time and give people who, like myself, are concerned as economists and as citizens too, a reasonably firm basis for believing what is said. Which I now do not.

LINSKY: I'll address myself to part of the question. We seem to be in agreement on part of it. And that is that the question of costs to the users versus the cost to the polluters is a pointed issue. The cost-benefit ratios, while popular and convenient in other kinds of circumstances, are not significant in this area of air pollution because of the large number of individual polluters and the large number of individual pollution receivers. We cannot escape as you can escape from polluted water by having it treated or by not going down to the river.

The other comment I would like to make is that the dollar signs that have been used, I think have sufficient basis. Dr. Kneese, I think, is a little short-changed in believing that the basis of the early, early, early figures of the 1900's were based on smoke. We still have Youngstown, Ohio which doesn't have smoke in the usual coal-burning sense. We still have Gary, Indiana; we still have Whiting, Indiana; we still have the Charleston-Kanawha-River Valley; we still have Buffalo, New York. We have city after city that is far more polluted from stationary sources than Los Angeles County. There are New York and Washington, D.C., which have a mixture of stationary- and mobile-source air pollutants. So I think there has been a mistake about even the basis on which Dr. Kneese discounts so readily the prevailing estimates.

KONHEIM: Even if we take Dr. Kneese's very conservative figure of $6 billion as the cost of pollution and compare it with the $3 billion figure which Fortune Magazine estimated as the cost of a total cleanup of pollution, I think it appears that cleaning up the air is in any case a bargain. I think that the public must be made aware of this bargain. They need to have it explained to them, because public resistance to air pollution control does occur when the controls and the legislation for controls start taking effect. You may have a great public outcry for control, but there also is a public outcry against it when personal sacrifices have to be made. The public must be made aware of the hidden costs which they are now paying for pollution. This is very basic to persuading them to fully support air pollution control programs.

GEORGE W. WALSH *(Chief, Air Pollution Training Activities, Public Health Service, Cincinnati):* We are involved with fairly strong programs to increase our mobility, Mr. McGrath. How much effort is being expended to decrease the amount of routine transportation required in our metropolitan areas?

McGRATH: This is an interesting question because it actually poses some of the dilemmas of urban development that show up in the context of air pollution. For example, we're doing some things to increase, not decrease, the mobility of individuals in metropolitan areas. A case in point is in the Watts area of Los Angeles, where the heart of the social problem is not in response to air pollution, particularly, but demands more mobility for more people. Experiments are being made to provide ways for these people to get to other places; to other jobs. The journey-to-work problem is presented in a very different way.

Our responsibility, or society's responsibility at this point, certainly would seem to be that provision of additional mobility does not provide one iota more pollution to the Los Angeles County atmosphere.

WALSH: We are certainly concerned with the difficulty of reconciling the footloose American public to more efficient transport systems and, at this point, the automobile seems to be the main problem. There are perhaps twenty metropolitan areas in the United States that will be developing mass-transportation systems that will significantly affect the journey to work.

We know that significant changes in air pollution can be achieved by eliminating journey-to-work trips from the daily load of vehicular traffic. In fact, to attest to this very point, a 13-percent reduction in the hydrocarbons was achieved in one experiment in the Chicago metropolitan area. But recognizing that it will be many years before those twenty cities achieve mass-transit systems, nonpolluting mass-transit systems, we are not really going to have many alternatives to provide right now for decreasing mobility.

KATHERINE PEDEN (*Commissioner, Kentucky State Department of Commerce, Frankfort*)*:* Dr. Stern, does TVA feel that it should purchase buffer land near its steam plants? If not, please discuss how such land may be held as buffer zones over a long period of time.

STERN: To be brief, in some instances, TVA has such buffer zones, along reservoirs which are near steam plants, because this is part of the terms for the acquisition of land for the construction of the reservoir. In cases where the land was acquired for multiple purposes, the reservoir may also perhaps in strategic cases be located near highways, railroads, etc. Bridge crossings of the reservoir are suitable industrial sites and then it's primarily within TVA's control to be sure that this land is used in the best possible manner.

When it comes to trying to encourage land-use which is equally strategically located but is not under TVA control, it is often necessary to work along the lines that Mr. McGrath mentioned and, at the very earliest stages of development of a reservoir, let's say, to engage the local planning agencies in the counties and the State agency to participate in the shoreline planning, and, hopefully the establishment of zoning in the area. Typically, at that early stage, the area is rural and does not have the land-use conflicts that appear later on. This is the best way of insuring the best use of such land. An additional possibility, and it's being increasingly used, is that communities which recognize the strategic value of such land will create a community-development corporation and, in one way or another, acquire this land for the community at a time when the cost is still reasonably low.

H

December 13, 1966

PANEL H

ECONOMIC AND SOCIAL ASPECTS OF AIR POLLUTION CONTROL

SECOND SESSION

Chairman H. H. Meredith, Jr.
Coordinator, Air and Water
Conservation, Humble Oil
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Houston, Texas

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". . . mechanical engineer . . . active in process and design . . . an area production engineer . . . now in charge of coordinating air and water conservation for his company . . ."

INTRODUCTORY STATEMENT

H. H. MEREDITH, Jr.
Coordinator of Air and
Water Conservation,
Humble Oil and Refining
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Being the only industrialist on this panel today, I am sure all participants will be alert to see if I exhibit any industrial bias.

If I have any bias of which I am aware, it is this—that government, industry, institutions of higher learning, and the public are partners, not antagonists, in the whole matter of air conservation, and more specifically in the matter of economic and social aspects of air pollution control. I am sometimes viewed with surprise by my industrial colleagues when I propound what to me is a self-evident fact, that it is government's proper function to determine the needs and the ways and means of regulation, and industry's function to furnish information on costs and other results affecting both ourselves and the public whom we serve, when legislation and regulation are under consideration.

Equally difficult for me to state without apparent bias is the premise that government must not abuse the responsibility to regulate, that it must regulate when and where necessary, and refrain from doing so when necessity does not demand it. Both industry and government share the responsibility to use the guidance and leadership available in the educational, research, economic and social potential of our educational system. We share the responsibility to be responsive to the wants, desires, and needs of society. Society has a right to have healthy air to breathe, and in my opinion, should also have pleasant air to enjoy within the limitations of its willingness to compromise between the obvious benefits of a highly mechanized and industrialized society and the less obvious economic and social constraints necessarily involved in urbanization and industrialization.

As in all other complex social problems, a concerned and informed public, making its desires known is a mandatory ingredient in deciding what to do and to what degree. It is heartening to me to see this conference so well attended by citizens who have realized and are willingly underwriting their responsibilities in these categories.

It is my sincere belief and hope that the forum provided by this conference may further sensitize all of us to the rights and the needs and the problems of each segment of society, as government, industry, universities, and the public address themselves to the problem of air quality control. It is in this context that I assume we derive the theme for this conference, *"Control now for clean air."*

". . . attorney . . . chief legal advisor on air pollution for Department of Health, Education, and Welfare . . . writes widely on air pollution field . . ."

FUTURE LEGAL AND LEGISLATIVE PROBLEMS IN AIR POLLUTION CONTROL AND POSSIBLE SOLUTIONS

SIDNEY EDELMAN
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Department of Health, Eduaction, and Welfare
Washington, D.C.*

The increasing scope of the demands imposed on the legal profession were brought home sharply to me when I read the assigned title for this presentation. It is difficult enough these days to perform the traditional function of a lawyer—that of making an informed prediction of how courts will decide a particular case. The title, however, calls not for mere prediction, but for clairvoyance in a field where visibility is often extremely limited. I hereby disclaim any such extrasensory powers.

There is, however, a value—and this is what I think the draftsman of the title had in mind—in discussing some of the knotty problems which face us in the air pollution control field in an attempt to structure them in such a manner as to facilitate identification of the key issues and thus make consideration of solutions more than mere random activity. With this understanding, I would like to consider with you some questions which have recently come into prominence.

MOTOR VEHICLE AIR POLLUTION CONTROL

The question of the authority of States to set standards for the control of air pollution from new motor vehicles will become an increasingly pressing one when the Federal Motor Vehicle Air Pollution Regulations[1] become applicable to 1968 models. Must new automobiles and trucks which have been certified by the Federal authorities as meeting Federal standards undergo State testing and approval as well?

While only the U.S. Supreme Court can finally decide whether the Motor Vehicle Air Pollution Control Act[2] and regulations issued under it displace and preclude State action regulating air pollution from new motor vehicles beginning with 1968 models, I think that those who administer, or urge enactment of, State legislation in this field should be aware of the clear intention of the Congress in enacting this legislation.

At the outset, the Act establishes a complete and pervasive system for the control of air pollution from new motor vehicles and new motor vehicle engines, extending to the importation of vehicles, with provisions for certification of compliance, records and reports, penalties, injunctive relief, and broad authority in the Secretary to establish emission standards. The sweep of this authority is clear from the statutory language which reads:

> Sec. 202. (a) The Secretary shall by regulation, giving appropriate consideration to technological feasibility and economic costs, prescribe as soon as practicable standards, applicable to the emission of any kind of substance,

> from any class or classes of new motor vehicles or new motor vehicle engines, which in his judgment cause or contribute to, or are likely to cause or to contribute to, air pollution which endangers the health or welfare of any persons, and such standards shall apply to such vehicles or engines whether they are designed as complete systems or incorporate other devices to prevent or control such pollution.

I wish particularly to call your attention to the clause reading "which in his judgment cause or contribute to, *or are likely to cause or contribute to*, air pollution which endangers the health or welfare of *any persons*" (emphasis added).

The emissions to be controlled—which are identified as "any kind of substances"—are not only those which cause or contribute to air pollution but also those which are *likely* to cause or contribute to air pollution which endangers the health or welfare of *any* person.

The breadth of this authority is on its face indicative of a Congressional purpose to leave no room, or indeed need, for the exercise of State authority in the same area. This purpose is clearly expressed in the legislative history of the Act.

In discussing the need for the legislation, the report of the Senate Committee on Public Works declared that it would "be more desirable to have national standards rather than for each State to have a variation in standards and requirements which could result in chaos insofar as manufacturers, dealers, and users are concerned." [3]

The House Committee on Interstate and Foreign Commerce [4] similarly rejected the possibility of multiple standards under the Act and declared:

> The Committee is convinced that motor vehicle exhaust control standards on a national scale are necessary and would be of benefit to the entire country. Public concern about this problem is clearly increasing, as indicated, for example, by the steps taken or proposed in many States, to deal with motor vehicle pollution. While the Committee is cognizant of the basic rights and responsibilities of the States for the control of air pollution, it is apparent that establishment of Federal standards applicable to motor vehicle emissions is preferable to regulation by individual States. The high rate of mobility of automobiles suggests that anything short of nationwide control would scarcely be adequate to cope with the motor vehicle pollution problem.

As Representative Halpern from New York stated in the House debate, "There can be no doubt that this is a Federal responsibility" and he declared that, in the field of motor vehicle air pollution control, "uniformity is absolutely necessary." [5]

The Congressional intent to occupy the field is, I think, plain even from this brief review of the legislative history, and the Supreme Court has long held that once Congressional intent to occupy the field is found, the inquiry as to the State authority is ended.[6] Even supplementary State legislation is then precluded.[7]

Moreover, the wisdom of allocating State resources to a field which calls for duplication of Federal effort, research, and expenditures and will lead inevitably to long and costly litigation, with less than an even chance of success on the merits, would appear open to serious question. This is particularly true when, as in most States, the challenge of dealing with pollution from stationary sources is still unmet, and there is a needed function for the States to perform in the inspection of motor vehicles equipped with air pollution control devices to assure the continued proper operation of such devices after the vehicles have been sold to the public.

INCENTIVES FOR POLLUTION CONTROL ACTIVITY

There has also recently been considerable discussion of economic incentives for pollution control action, particularly in the private sector of the economy. This has been accompanied by suggestions for a negative incentive or, if you please, a "disincentive," for pollution. The latter approach has generally taken the form of "effluent" charges which would be related to the pollution discharged from each source.

The effluent tax approach apparently stems from a misunderstanding of charges imposed by Genossenschaften in the Ruhr, Germany, upon industries discharging waste into the streams.[8]

The Genossenschaften are responsible for the development and execution of waterwaste disposal plans, among other things, and the construction and operation of necessary treatment facilities.

As an example of this operation, the Emscher River has been fully lined with concrete and is used exclusively as an open sewer. Near its mouth, the entire flow of the Emscher is treated to remove most of the suspended matter by a single plant constructed and operated by a Genossenschaft. The cost of this activity is paid by the members of the organization, and membership is compulsory.

In substance, the Ruhr effluent charge is far from a license to pollute or a tax upon pollution but represents each individual plant's proportionate share of the cost of operating a regional water-waste treatment program, and is related to the effluents discharged by it.

In recent hearings before the Subcommittee on Air and Water Pollution of the Senate Committee on Public Works (Water Pollution Control—1966, S. 2947, etc., 89th Cong., 2d Sess.), the question of utilization of effluent charges as a deterrent to water pollution came up for discussion in view of a provision in section 104(b) of S. 2987 relating to such charges. This proposal was finally withdrawn by the Department of the Interior, with the statement that it viewed the idea "not as a license to pollute, but as a system of charges to pay the cost of cleaning up pollution."[9]

Whatever the applicability of this view may be to water pollution, air pollution cannot be "cleaned up" after the pollutants have been emitted into the atmosphere. Man's water can be, and usually is, subject to elaborate purification before it is distributed to him for drinking, but he must breathe the air as it comes to him—pollutants and all.

A different approach was taken by the U.S. Congress in Public Law 89–800, enacted November 8, 1966. That Act suspended the investment credit for certain facilities for the period October 10, 1966 through December 31, 1967 but exempted from this suspension water and air pollution control facilities which meet specified conditions. In the case of an air pollution control facility, it must be section 38 property which:

(1) is used primarily to control atmospheric pollution or contamination by removing, altering, or disposing of atmospheric pollutants or contaminants; and

(2) is certified by the State air pollution control agency as being in conformity with the State program or requirements for control of air pollution and is certified by the Secretary of Health, Education, and Welfare as being in compliance with the applicable regulations of Federal agencies and the general policies of the United States for cooperation with the States in the prevention and abatement of air pollution under the Clean Air Act.

In addition, the facility comes within the exemption only if the taxpayer constructs, reconstructs, erects, or acquires such facility "in furtherance of Federal, State, or local standards for the control of . . . atmospheric pollution or contaminants."[10]

Even though the implementation of these provisions has not yet been completed, the purpose of the Act is unmistakable. The tax benefit made available under these conditions is plainly intended as an incentive, even if a limited one, to encourage the construction of air pollution control facilities.

States which are considering tax benefit incentives might do well to consider the question whether a provision limited to air pollution control facilities, in certain contexts, would achieve the maximum incentive effect of a tax benefit approach. Without going into the merit of the use of tax credit or other forms of tax benefits as an incentive for air pollution control—a subject beyond the scope of this paper—under the concept of a negative incentive for air pollution the suggestion has been made that such tax benefits, if used at all, be denied to facilities without air pollution controls. For example, if a tax benefit, such as exemption from real property, personal property, or franchise taxes, is made available for certain types of property, this benefit might, in the case of facilities which are potential sources of air pollution, be conditioned on the inclusion in the facility of adequate air pollution control devices. In other words, the benefit would not be available just for the air pollution control installation, or for the air pollution control installation as well as the rest of the facility; rather the benefit for the *entire facility* would be available only if suitable provision is made for the control of air pollution.

This, of course, is only one of a number of possible incentive devices which could be utilized, all of which should be carefully considered in the development of State legislation.

LEGISLATIVE ORIENTATION

Finally, legislative approaches to air pollution problems must arise from a social context which involves more than financial values. The development of social legislation must be preceded by the development of the social philosophy which serves to identify the legislative goals. In the field of air pollution, this philosophy is already well defined, and is constantly being sharpened.

Over 100 years ago, Benito Juarez, then President of Mexico, declared, "The respect for the rights of others is the foundation of peace."

We have since recognized that respect for the rights of others is also the foundation of a decent environment. The 1965 report of the Environmental Pollution Panel of the President's Science Advisory Committee urged national acceptance of the principle that "The public should come to recognize individual rights to quality of living, as expressed by the absence of pollution . . ." [11]

This thought was emphasized by President Johnson in his "Creed to Preserve our National Heritage" [12], when he proclaimed, as essential elements of this creed, ". . . The right to clean air—and the duty not to befoul it." He concluded with this declaration:

> These rights assert that no person has a right in this day and age to pollute, to abuse resources, or to waste our common heritage.

In short, the major premise of air pollution legislation is, and must continue to be, "There is no right to pollute!"

REFERENCES

1. 42 CFR Part 85.
2. Section 101, P.L. 89-272, Oct. 30, 1965; 42 U.S.C. 1857f-1 et seq.
3. S.R. No. 192, 89th Cong., 1st Sess., p. 6
4. H.R. Rept. No. 899, 89th Cong., 1st Sess., p. 5.
5. Cong. Record, 9/24/65, p. 24149.
6. Oregon-Washington Co. v. Washington, 270 U.S. 87 (1926); Napier v. Atlantic Coast Line RR Corp., 272 U.S. 605 (1926); Rice v. Santa Fe Elevator Corp. 331 U.S. 1947.
7. Guss v. Utah Labor Relations Board, 353 U.S. 1 (1956); Campbell v. Hussey, 368 U.S. 397 (1961).
8. The operations of the Genossenschaften are discussed in Chapter 7 Waste Management in the Ruhr—A Case Study of the Genossenschaften, of The Economics of Regional Water Quality Management by Allen V. Kneese, published by Resources for the Future, Inc., 1964.
9. Page 138a, Hearings before the Subcommittee on Air and Water Pollution of the Senate Committee on Public Works—Water Pollution Control—1966, 89th Cong., 2d Sess. At p. 397 of the hearings, Senator Muskie stated the operation of the effluent charge as follows:

   > The so-called effluent tax is supposed to be drawn from what is, I think, misunderstood as the Ruhr experience in Germany. As I understand that, following our visit there with Secretary Udall, the Ruhr system is not that at all.
   >
   > The policy in the Ruhr is this: We are going to clean up every drop of effluent now discharged into our streams. We are going to make a charge against all polluters against their proportionate share for the cost of cleanup. To the extent that polluters will take care of their own pollution, to that extent will they be given a discount from the charge related to the cost of community facilities.
   >
   > It is not an alternative. The waste dischargers are not given this choice: "Well, you pay this tax and pollute, or clean up and not pay the tax." It is not that kind of deal in the Ruhr, as I understand it.
10. 28 U.S.C. 48(h) (12) (C), (D) as added by Public Law 89-800.
11. Restoring the Quality of Our Environment (1965), p. 16.
12. Presidential Message, Preserving Our National Heritage, February 23, 1966; H. Doc. No. 387, 89th Cong., 2d Sess., pp. 9-10.

". . . engineer in aviation and automobiles . . . president, Southern California Aviation Council . . . Chairman of pollution committee, National Association of Counties . . ."

DISCUSSION

FUTURE LEGAL AND LEGISLATIVE PROBLEMS IN AIR POLLUTION CONTROL

WILLIAM J. PHILLIPS
Supervisor,
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It is a great pleasure to have the opportunity to comment objectively on the paper just presented. This entire conference has been pointed toward the theme of air pollution control now. Yet we have to be concerned with the underlying issue of whether or not the American people are legally, legislatively, politically, economically and socially ready to control for clean air now.

The average American does not think about daily air pollution problems except when an air pollution alert hits his area. Then he is ready to go along with positive programs. However, we have a continuing program to keep our constituents aware of the problems of maintaining clean air.

As an individual who has been close to air pollution problems for some ten years, I am deeply concerned that time is running out. We cannot hope to pace ourselves in the future as we have in the past. Further, we cannot continue working in our small groups alone. The "inner group" philosophy was justified in past years because of technical problems and the need for research, but today air pollution has to be dealt with on a more political and more social basis. Immediate control implies bold, new action—it involves massive public education and social adjustment.

Planning, especially on the local level, is a very integral part of the entire picture. When you bring industry into an area, you bring in clean industry that does not pollute the air and does not pollute the water. My feeling is that those industries which provide adequate control and spend money to solve the problem, should not have to pay ad valorem taxes on the control part of their installation.

In our area it is most important that we keep people and prevent industries from moving into new areas because of pollution control. However, many of the political leaders of this Nation have not identified the problem or have not yet learned to combat the problem of air pollution.

As John Fairweather so ably pointed out to the Air Pollution Control Association, about half the States have enacted air pollution legislation, but only after the 1963 Clean Air Act created the Federal program of financial grants to State, local and interstate agencies. At that same meeting, Dr. William Stewart, Surgeon General of the

United States Public Health Service, estimated that only 58 percent of our urban population is served by local air pollution programs.

We are apparently lagging far behind the 100 percent cooperation needed on all levels of government. Even though the Clean Air Act has encouraged States and communities to organize air pollution control ordinances, a lag of almost 50 percent of our Nation is a deplorable situation. Let me just state a few figures which I think you will find alarming as I do. In my home state of California, agricultural damages are estimated to be over 132 million dollars a year. The culprit which causes this loss is air pollution.

By the year 2000, it is estimated that the population of the United States will be 325 million people. This will mean that use of energy will increase threefold, and 80 percent will be derived from fossil fuels. Emission of sulfur oxides may be expected to be 40 million tons, double that of 1960. Emission of oxides of nitrogen can be forecast as 35 million tons, triple that of 1960. Carbon monoxide will increase almost fourfold to 465 million tons. This is frightening.

Vernon MacKenzie, deputy director of the Bureau of Disease Prevention and Environmental Control, United States Public Health Service, made a number of comments in his testimony before the Senate Committees, and I concur with much of what he has said.

The situation might well begin to worsen with the increase in automobiles. We are going to have to develop technological advances and think about such things as power cells, non-contaminating fuels, etc.

As the County Supervisor in the fastest growing county and area in this Nation, I see this cold, relentless mathematical maze in my everyday operations. For example, in Orange County we have a population of slightly over 1,200,000 people. The vehicle registration is 645,947. As you can see, we have more than one car for every two people. This in itself is alarming, but look at the rate of increase. Vehicle registration increases at a rate of 10.6 percent per year; the population increase is 4.2 percent.

In the entire Southern California area (Fresno to Imperial County) since 1960, the rate of population growth has been 22 percent, but there has been a 32.1 percent increase in vehicles. This mathematical escalation of vehicles over population is startling to any of us who work to achieve clean air.

Therefore, we must have a crash program for air pollution measures. Air pollution is a substantial threat, bordering on an epidemic of disaster proportions. When the American people are thus threatened, you and I must scream out the message until we get it across. Just as public health authorities must take extreme and harsh measures when combating malaria or typhus, so must we arouse the American people to support the immediate programs for air pollution eradication.

In California, we are at last taking the "substantial threat" approach. A 1966 statute requires our State Department of Public Health by February 1, 1967, to define criteria concerning the levels, duration and frequency of occurrence of contaminants in the atmosphere, including the contaminants emitted from motor vehicles, which, if occurring in the atmosphere of any area in the State of California, will pose a substantial "threat" to the public health or to protection of persons and property.

The major entry of the Federal Government in the field of air pollution has, of course, been most helpful. It has taken a long time to get the bills passed and implemented. Only now, however, is the Federal Government setting up a Major Vehicle Compliance Laboratory in the Detroit area. And in California we certainly know from years of bitter experience that research and testing are painfully slow. And we are running out of time.

I am concerned with the 1980 figure, so I believe that all levels of government must cooperate. We must choose and we must integrate our systems at the levels at which they can be best enforced at the lowest cost with the most efficiency. I would shudder to think that the Federal Government would have to pose an army of people throughout the nation to test emissions from each car. I suggest that stamps, stickers and local checking are far more efficient and will work far better. I feel that a State highway patrol with a coordinated motor vehicle department which allows licensing only after the automobile passes specifications is the simple and easy way to handle automobile emission. National standards must be established because cars are mobile things.

Enactment of local laws and ordinances is also involved. We have just completed our local air pollution control regulations and ordinances. They are in the hands of my fellow Supervisors and are being reviewed with Western Oil and Gas, the Edison Company, the gas companies and the League of Cities, to coordinate the entire program. We have found in our area that coordination and cooperation among the local agencies has been quite successful at a very low cost. We do not just say arbitrarily that we preempt the field of motor vehicles, but we feel that these are levels that should be met. This guideline can be best enforced by the local agencies. We found that industry has been very cooperative in many areas. Most of our industries and Chambers of Commerce have helped. Working at air pollution as a crash program and not just thinking about 1980 as a target, we can be successful.

A man can live two weeks without food, one week without water, and less than three minutes without air.

This is one of our most important problems. In the field of law and legislation, local zoning, local enforcement, licensing control and compatibility of regulations will be the true solution to our problems.

". . . economist . . . taught in England and at M.I.T. . . . consultant to Council of Economic Advisers and Bureau of Budget . . ."

FEDERAL FISCAL POLICY IN AIR POLLUTION CONTROL

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I am going to take two liberties with the topic assigned to me. First, I am going to include in my discussion some nonfiscal policies toward air pollution, since the basic public policy issue centers on the choice between fiscal and other policies to combat air pollution. Second, I am going to exclude from discussion any pollutants resulting from motor vehicles. Although automobile effluents are very important, the problems are somewhat different from those of effluents from stationary sources, and I think they deserve special consideration. Thus my paper is broader in one way and narrower in another than is suggested by my title.

THE PUBLIC POLICY PROBLEM

In its most fundamental aspect, the economic problem of air pollution is well understood. The discharge of wastes into the air is one of the classical examples of what economists call "external diseconomies." Clean air is a natural resource available in limited quantities at a given time and place. Except under special circumstances, it is not bought and sold in the free market. Rather, it is treated as a free good. In the absence of special public policies, however, users often find it in their interest to change its composition in the course of using it. Respiration is presumably the first way that man's activities affect the composition of air. But, in a modern industrial society, almost every productive process affects the composition of the air in the vicinity, sometimes in minor and sometimes in major ways.

The composition or quality of air affects the utility or profitability that can be derived from its use. Both human beings and their property are affected by the quality of the air they use. Rather little is known about the effects on human health and comfort of air of various qualities, especially about the chronic effects of low levels of pollution. But such effects are not necessarily small. More is known from laboratory studies about the effects of various kinds of pollutants on materials, but overall magnitudes of annual damage have yet to be calculated.

The externality results very simply from the fact that users change air quality without taking full account of the costs—monetary and other—that such changes impose on others.

In an abstract way, the public policy problem can now be stated very simply. Calculate the damage that will result to each receptor of polluted air from discharges of various kinds and amounts of effluent from each source. This calculation gives us the benefits that will result from abatement. Next, calculate the cost to each source of each pollutant of discharging various amounts of the pollutant, the presumption being that the less of the pollutant that's discharged, the greater the cost to the source. This calculation gives us the costs that will result from abatement. Then optimum public policy will assign to each source of pollution an amount to be discharged that will equate the marginal cost of abatement to the marginal benefit of abatement.

Like any highly abstract statement of a complicated problem, this one leaves unanswered a number of difficult questions. By way of elaboration, I offer the following comments.

First, the benefits of abatement vary with the time of day, day of week, season of year, and with partly unpredictable weather conditions. This means that benefits of abatement depend on a number of characteristics of the discharges, and are probabilistic in nature. Similar problems arise with water pollution, but the dimensions of the problem appear to be fewer and better understood with water than with air pollution. For example, in many areas the most severe water pollution occurs with great regularity in late summer. Any variations by hour of day and day of week are frequently unimportant.

Second, the relevant unit for air pollution abatement—the metropolitan airshed—is less well defined than the relevant unit for water pollution abatement—the watershed. Pollutants that enter streams normally go only one way, at more or less predictable speeds and in predictable channels. Pollutants that enter the air may go toward any point of the compass. And the extent to which they go up—a direction not relevant for water pollution—is often crucial in determining the damages from air pollution.

Third, less is known about the chemical action of pollutants in the air than of those that enter water. And less is known about the regenerative properties of the atmosphere than of streams.

Fourth, less is known about metering the discharge of pollutants to the air than of those in streams. And, as I indicated above, rather little is known about the benefits of air pollution abatement, especially as regards benefits to human health.

Fifth, we know rather little about the efficacy of alternative tools of public policy to abate air pollution. In the case of water pollution, there are decades of experience with effluent fees and other fiscal incentives to draw upon, although our own Federal authorities have been notably unwilling to learn from foreign experience. In this country, we have many years of experience with Federal enforcement policies regarding water pollution. No such bodies of experience exist regarding air pollution abatement policies.

ANALYSIS OF ALTERNATIVE PUBLIC POLICIES

What then are the available public policies to deal with air pollution, and how should we choose among them? It is convenient to classify possible policies under the headings of regulation and enforcement, payments, and charges. The first category is nonfiscal: the last two are fiscal. Under regulation and enforcement, I include the setting of air quality and effluent standards, and the enforcement of standards through regulatory bodies and the courts. Under payments I include grants for abatement equipment and payments for reductions in discharges. I also include reductions in collections, such as rapid depreciation, tax forgiveness and tax credits for abatement equipment. Under charges, I include taxes on production processes that generate large amounts of waste, and effluent fees.

Existing Federal abatement policies are contained in the Clean Air Act of 1963 and its 1965 amendments. Parts of these laws deal with research, development, demonstration and training programs, and with cooperative activities with states and the promotion of uniform laws. Insofar as they deal directly with air pollution abtement, they fall entirely in the category of regulation and enforcement. The Federal Government is empowered in limited circumstances to engage in enforcement activities, culminating in legal proceedings. It does not yet have the power, recently granted in the area of water pollution, to set and enforce standards.

How can we evaluate these and other possible policies? The first thing to say is that there is a strong practical argument against most of the policies under the payments heading. They are simply payments for the wrong thing. The investment credit proposal will illustrate the deficiency that is common to all others. An investment credit on air pollution abatement equipment reduces the cost of such equipment. But most such equipment is inherently unprofitable in that it adds nothing to revenues and does not reduce costs. To reduce the cost of such an item cannot possibly induce a firm to install it. The most it can do is to reduce the resistance to public pressure for installation. Common sense and scattered bits of evidence suggest that these payments policies are costly and inefficient ways to achieve abatement. Furthermore, such schemes bias the choice among alternative abatement devices in an inefficient way. For example, an investment credit for equipment to filter particulates out of smokestack gases would bias firms against the use of fuels that emit little particulate matter. Thus, I contend that payment schemes are largely ineffective, and to the extent that they are effective they obtain abatement inefficiently. The only argument in their favor—and this accounts for their popularity in Congress and elsewhere—is that there is less resistance to the Federal Government giving away money than to proposals to regulate or institute charges.

A similar argument can be made against the proposal to pay for the abatement of discharges, although the issue is somewhat more complicated. The conclusion, however, is that payments for the abatement of effluent discharges are a costly and inefficient way to combat pollution.

This leaves us with a choice between effluent fees and enforcement policies. In evaluating these two alternatives, the first thing to note is that there is a formal equivalence between them. If one knew the schedules of benefits and costs that I referred to earlier, one could proceed in either of two ways. First, we could calculate the optimum discharge from each source and impose that rate on the discharger by some administrative action. Second, we could calculate the schedule of effluent fees that would induce the discharger to abate his discharges to just the optimum level. And the result would be precisely the same under either policy.

How then does one choose between regulatory and effluent fee schemes in formulating air pollution abatement programs? The choice must be made on practical, rather than theoretical, grounds. I believe that the following four points cover the major practical considerations in making this choice:

1. The advantages of flexibility can be enormous. What I mean by this can be illustrated as follows: Suppose that one wants to reduce discharges in a metropolitan airshed so that air quality everywhere in the airshed meets some stipulated standard. One way to do this is to induce each discharger to reduce his discharge by x percent, where x is chosen to meet the stipulated standard. Another way to do it is to abate selectively, abating by relatively large amounts among those dischargers for whom the costs of abatement are relatively low and from whose abatements the benefits are relatively great. In terms of the costs of abatement, the first alternative might be two to ten times as expensive as the second. Evidence for this comes mostly from studies of the analogous problems in water pollution, but also from one or two interesting studies of air pollution. It is not surprising that abatement is much cheaper for some dischargers than for others; and that the bulk of the damage from air pollution in a metropolitan airshed comes from a rather small number of sources. Flexibility of this kind is not impossible to achieve with enforcement schemes. But our experience with water pollution suggests strongly that it is unlikely to be achieved by enforcement schemes. Effluent fees, on the other hand, achieve at least part of the desired flexibility automatically. If each discharger is faced with the same schedule of effluent fees, abatement will be relatively great among those dischargers for whom abatement is relatively cheap. And this would come about simply through the self-interest of the dischargers. If, in addition, it proved possible to confront dischargers with different effluent fee schedules according to the benefits to be derived from abatement, then complete flexibility would result. Although perfection could not be achieved, some flexibility in setting schedules would be practical. Lower schedules could be assigned to dischargers with higher smokestacks, or to those located

on the leeward side of the airshed, for example. On the other hand, experience with enforcement cases in water pollution shows this to have been a very cumbersome procedure indeed. Many cases drag on for a decade or more. At the end of that time, an unsophisticated plan—such as secondary treatment for all major discharges—is put into effect. This not only lacks flexibility, but also runs the risk that conditions will have changed so by the time the plan is implemented that it will be obsolete.

2. Effluent fee schemes have the advantage over the enforcement schemes that they place the burden of investigation and decision-making in the hands of management rather than of government officials. The cheapest way to achieve a given degree of abatement is usually a complex combination of process changes and treatment of the effluent by filtering and other means. The management of the enterprise is usually much better placed than government officials to know what abatement scheme is best in the host of special circumstances surrounding each situation.

3. Effluent fee schemes provide dischargers with a continuing incentive to search for additional ways of abating discharges as long as any fee is being paid. An enforcement action, on the other hand, requires the discharger to take certain specific actions. Having taken them, he has no incentive to seek additional methods of abatement.

4. Both effluent fee and enforcement programs require the ability to measure discharges and the benefits and costs of abatement. Both programs are equally dependent on these measurements for their success. However, the inability to obtain relevant measures will show up more quickly with an effluent fee scheme than with an enforcement program. An enforcement program might, for example, require stacks of a given height or a certain kind of filtering of stack gases without being based on relevant measurements. With an effluent fee scheme, on the other hand, we would not even know how much to collect without at least being able to measure discharges. In a state of great ignorance this may be an important argument for regulatory enforcement. For example, if it were known that, in a certain city, people's eyes were burning because of emissions from steel plants, it might make sense to require filtration of these emissions even if one had no way of measuring the amount of such emissions.

The inference from these four points is that enforcement programs are crude and cumbersome in comparison with the flexibility and sophistication that would be permitted by effluent fee schemes. Enforcement programs nevertheless have their place. They permit the government to do something even when it has almost no notion of the relevant measurements. Furthermore, the strength of the argument for effluent fees rests on the assumption that people act efficiently to achieve their own self-interest. And usually they do. But not always. Sometimes they may lack the knowledge or intelligence to do so. The former deficiency may be overcome in part by government technical assistance. But enforcement programs are probably needed for those cases in which people fail to react in their own self-interest, or in those cases in which it may not be possible to correct health and other hazards by effluent fees.

A PROPOSAL

I believe that the relevant Federal operating agencies have been guilty of dereliction of duty in being unwilling to consider seriously the adoption of effluent fees as part of our water pollution control scheme. Effluent fee programs for water pollution control have been studied by scientists and economists, both in the Government and in private institutions. They have been recommended by advisory panels and task forces of scientists, engineers, economists and others, including the Environmental Quality Task Force. Effluent fees have been used successfully in Germany for years. They are being studied or adopted in other European countries. Yet too often the response in our own Federal operating agencies has been little more than to accuse proponents of the scheme of wanting to sell the right to pollute.

In the case of air pollution, things are different and more complex. No country has ever instituted or, to the best of my knowledge, carefully studied, an effluent scheme for air pollution abatement. Herein lies my challenge. We should take the lead in this country in studying carefully and sympathetically the possibility of incorporating effluent fees into our air pollution abatement program.

Specifically, I recommend the following program:

1. The success of any air pollution abatement program requires an air pollution control agency with authority throughout a metropolitan airshed. In most major metropolitan areas, such an agency's authority must cross city boundaries, and in some cases, it must cross State boundaries. Such authorities are unlikely to be set up in a reasonable period of time and with adequate powers unless substantial Federal encouragement, presumably in the form of matching grants, is forthcoming.

2. Each metropolitan airshed authority should have the authority and the resources to study the benefits and costs of air pollution abatement in its area. It should attempt to establish goals or standards for optimum abatement of pollution within its jurisdiction. Standards should not, however, be a mere perpetuation of the status quo, which is what appears to be happening in the current rush to set water quality standards in response to recent Federal legislation. Rather, standards should be measures of justifiable abatement of pollution, based on careful calculations of benefits and costs.

3. Metropolitan airshed authorities should, of course, investigate the mix of policies that appears to have the best chance of achieving optimum abatement in each area. No one should believe, however, that metropolitan authorities will be given the resources to work out the technical problems or the authority and encouragement to establish effluent fees unless the Federal Government takes the lead. What is needed is for the Federal Government to take the lead in finding practical ways to meter the discharges of major effluents, to predict their diffusion patterns, and to measure their effects. Only if appropriate Federal agencies are able to show that effluent fees are an efficient way to improve air quality in our metropolitan areas, will there be any chance of putting them into practical use. Even then, fiscal encouragement and technical assistance would probably be necessary to induce metropolitan authorities to make effluent fees a major part of their air pollution control program.

". . . professor at Columbia, University of Virginia, and American University . . . economist in industry and consultant to government agencies . . . author of Economics of Air Pollution . . ."

DISCUSSION

FEDERAL FISCAL POLICY IN AIR POLLUTION CONTROL

HAROLD WOLOZIN, Ph. D.
Professor of Economics
University of Massachusetts
Amherst, Massachusetts

I do not believe that any discussion of federal fiscal policies in air pollution control can justifiably or arbitrarily exclude the abatement of auto exhaust emissions. I hope that it is not Professor Mills' preference for the use of effluent fees over other available alternatives and the obvious inapplicability of this solution to the auto problem, rather than its complexity, which dictated a decision to exclude the auto from his paper. I shall defer to his decision, but my recommendations should be interpreted as encompassing the auto problem.

In a paper which Emanuel Landau and I delivered a year ago at the joint meetings of the Econometric Society and the American Farm Economics Association, we traced the long history of research, pioneered overseas, on the development of techniques to measure direct damages of sulfur dioxide to crops. We pointed out that measurement techniques developed here and abroad have thus far been confined to direct effects of high levels of contamination. We recommended top priority to be given to research on measuring indirect effects and the insidious, perhaps more profound effects, of low level exposures of long duration, an area about which little is known and much suspected. Other pollutants such as carbon monoxide, ozone, nitrous oxide, asbestos particles, products of photosynthesis, radioactive particulates, etc. give us an impressive list of pollutants whose "chemical action," levels of discharge and patterns of damage are still in good part a mystery to us.

Granted this, however, I must ask how relevant is it to our problem at hand to emphasize that we know more about polluted water than polluted air? The important question for policy purposes is: "How much *do* we know?" For, if we know that the damage is already extensive, that the prospects for the future are grim, and that a good deal of the damage is progressive and irreversible, then our policy recommendations should, it seems clear, be quite different than if time were not of the essence and the damages were remediable. The fact of the matter is that, although at times we may be dismayed by the unanswered, we should not forget that we have found out a great deal about the damage already done; and evidence of the threat of uncontrolled emissions is mounting. In the case of sulfur dioxide, Landau and I warned that even with the increased use of sulfur dioxide-free natural gas and nuclear power, "nonetheless, by the year 2000, the growth in population, industrial activity, and commerce in the United States, will, in the absence of effective control, still double the level of sulfur dioxide in the air over the 1960 level. This is an unparalleled threat to the quality of our air." It is even more so if the indirect and chronic low level effects are introduced.

Research evidence of the grave threat to health and property is accumulating. Dr. Warren Wincklestein and his associates at the medical school of the University of Buffalo recently found dramatic evidence of the link between cancer and air pollution. It is clear to me that there is reasonable ground to question the inference of Professor Mills that, because we know less about air than about water pollution, there is ample time for experimentation with effluent fees, an approach whose outcome is fraught with mystery and whose chance for achieving the desired pollution abatement is far from certain. However, Mills' summary dismissal of the possibility of working from the expenditure side of the fiscal policy axis and his distaste for regulation leave him little choice. Couple this with his faith in our ability to manipulate the market mechanism and the die is cast. I am, however, skeptical.

My skepticism is based on the unfortunate fact that we do not know enough in an empirical way about the effects of taxation on business policies and human behavior to be at all certain about the outcome of any scheme of tax like effluent fees. Even the underlying theory can be questioned. As Richard Musgrave points out, any theory of the shifting and incidence, and the effects on productive activity, of any system of taxes (in our case effluent fees) is only as good as the theory of production and/or distribution upon which it is based.

I infer that Professor Mills' model is a conventional neoclassical model of business behavior in which any system of effluent fees imposed upon the cost structure of businesses will allegedly bring either a shift away from emission-producing activities toward alternative methods of production or the introduction of devices to lower emission levels and effluent fee bills.

This is all very good if one accepts the single valued model of decision which is implicit in this model. However, more than one scholar has challenged this economic model, on the grounds that it requires a view of business behavior which is far from reality. Some would even go so far as to replace it with a sociological analysis of business behavior.

The econometrician, Henri Theil, writes, for example: "Whereas the microeconomic neoclassical theory of distribution was based on a postulate of rationality suited to their static analysis and institutional assumptions, we are no longer justified in accepting this basis and are set the problem of discovering the value premises suited to exceptional analysis in the institutional nature of modern business. The neoclassical postulate of rationality and the concept of the entrepreneur as a profit maximizing individual should, I think, be replaced by a sociological analysis of the goals of the firm in relation to its nature as an organization within the social, political system."*

This is not the place to go into the contrast between the image of economic man implicit in this formulation as contrasted with the Mills image, and we do not have to go as far as Professor Theil to sympathize with the flat charge which I quote in another paper. "Emission charges bring unpredictable responses!" Cannot this be translated into, "business management doesn't behave in the way the neoclassical models say it should?"

In a discussion of this nature, I have only been able to consider briefly what economists have known for a long time: our ability is rather poor in predicting with any reasonable accuracy the effects taxes or fees have on investment decisions. Changing or modifying equipment is investment. Therefore, I cannot accept with any complacency or comfort Professor Mills' proposal for broad-scaled experimentation with such fees. Furthermore, he is aware, I am sure, of the technical difficulties involved in levying such fees, for in one section of his paper he points out that in a state of "great ignorance" about the levels and measurement of discharges, measures other than effluent fees are in order. Yet, even if one could measure discharges and damages, and hence set standards for reduction levels, why would Professor Mills not accept the proposition that our uncertainty about the effects of taxes and fees on business decisions militates against the practicability of a system of effluent fees to abate air pollution with any predictable or reasonable degree of success? One can envision a splendid array of potentially dismal surprises which might result—mislocation of industry, bizarre price and cost reactions, etc.

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*Theil, Henri. Optimal Decision Rules for Government and Industry, 1964. Page 71.

One further point along these lines: even according to the conventional economic decision model, irrational economic units are regularly willing unwillaible market goals. This raises additional serious questions about the realism and reliability of the conventional economic decision model in determining air pollution policy. On the basis of this model, can air pollution control authorities predict viable reactions to policies in oligopolistic situations? Will a tax on emissions elicit the anticipated response?

I should like to consider the possibility that the picture is not as black as it seems: that if we will accept a broader view of both the air pollution problem and the nature of business-government relations than is implicit in Professor Mills' presentation, we have a possible solution along the lines most summarily dismissed by Professor Mills.

The air pollution problem poses the need for a serious rethinking of the alternatives at hand with which to influence management decisions affecting externalities. Although this would require extensive study and imaginative research—research which might well ask if effective control will not ultimately demand basic modifications of traditional government-industry relations as has been the experience of most of the other Western nations—public concern over environmental and other hazards generated by our burgeoning economy may well demand such radical thinking on the part of social scientists and government officials.

Industry may be more cooperative than many would suggest. Basis for expecting this is suggested by what has happened elsewhere in the world. For example, the French government participates directly in management affairs, yet it is a participation dependent upon a spirit of "good will" rather than coercion. Study of the implications of such involvement by air pollution authorities might be a fruitful introduction to facets of control which up to now have received scant attention.

Suppose the air pollution authority is given the authority and resources to pay for air pollution filtering and control devices or bear the cost of modifying existing equipment. In return for this, it would receive the right through public commissions, such as now exist for the utilities, to participate in corporate decisions affecting the emissions of pollutants. This certainly would raise possibilities and issues which may face us in the future as the public demand for effective control mounts.

"... more than a quarter of a century service in Congress ... known as 'Mr. Public Health' ... Lasker, Kennedy, and Heart Association awards ... holder of a score of honorary degrees ..."

A CONGRESSIONAL VIEW OF THE ECONOMIC AND SOCIAL ASPECTS OF AIR POLLUTION

JOHN E. FOGARTY*
Late Member of Congress,
Second District
Rhode Island

I accepted an invitation to participate in this panel on the economic and social aspects of air pollution control with great pleasure and keen anticipation. I am primarily interested in the health aspects of air pollution, but as a member of Congress I also must be concerned with the general welfare—and this most certainly includes economic and social matters. In fact, I do not know of any major health problem that does not also have major economic and broad social implications. This is true in particular for environmental health problems.

The problem of economic and social relationships is one of the most difficult areas in air pollution control. Many facets of the physical and biological sciences relating to air pollution are not clearly understood. But with the application of ingenuity and with sufficient time we can look to solutions.

We must look to the social sciences to develop with increasing accuracy and frequency, relevant information on the economic impact of air pollution on industry, communities and the nation. We must look to you for some of the means to achieve effective air pollution control.

As a public health goal in this field, I suggest the World Health Organization's definition of health, stated in the preamble to its constitution. "Health," it says, "is a state of complete physical, mental, and social well-being. . . ." It concludes, "Governments have a responsibility for their people which can be fulfilled only by the provision of adequate health and social measures."

It's easy to say, "Oh, come now, that's pie in the sky. When we talk about goals we need to discuss specific, attainable objectives, not broad generalities that justify almost any course of beneficial action and dictate none." I remind you that the specifics of our American political system have their basis in broad, general statements. I am very thankful that our founding citizens, in establishing our rights to "life, liberty, and the pursuit of happiness," did so without extensive qualification. I am sure that there were cautious men among them who felt that economic and social inevitabilities such as slavery, debtors' prisons, inhuman working conditions, etc., should be recognized. But such qualified goals are for cautious men and modest objectives.

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*Shortly after this address was given, Mr. Fogarty suffered a heart attack in his Washington office and died on January 10, 1967.

I believe that the environmental conditions under which an increasing majority of Americans *are required to live* are not inevitable.

One of the most important things to remember about air pollution is that it is only one of a number of environmental factors which affect man's wellbeing. Therefore, an attack on air pollution must be part of a larger attack on environmental problems. It is in this context that we must consider the future of air pollution control by the U.S. Public Health Service.

With the conviction that time will prove their validity and, to fix them in your memory, I reiterate the opening and concluding statements of the WHO constitutional preamble: "Health is a state of complete physical, mental and social well being, and not merely the absence of disease or infirmity. . . . Governments have a responsibility for the health of their people which can be fulfilled only by the provision of adequate health and social measures."

That's what we're after. Now, what do we regard as the economic and social problems associated with the attainment of this goal?

There are various estimates of the cost of air pollution and of the amount spent to control it. I am sure they all have been prepared by able men. And because of the vast number of factors to be considered and the difficulties of measurement. I also suspect that no one of these estimates is really accurate. Their range of magnitude is indicative.

A report this year by the National Academy of Sciences-National Research Council estimates air pollution costs the U.S. $65 per capita per year. It states that the latest available figures—those for 1962—indicate that our control programs cost us about 11 cents per capita. And without the State of California—which knows it has a problem and has been spending money to do something about it—the national cost for the control of air pollution would drop to about a nickel a head.

As a noneconomist, as a member of Congress who sees his job as the promotion of the public health and the protection of the community, I reach the same conclusion about both these figures. When you're talking about a nickel or a dime per head for control, versus $65 for damage, it suggests *to me that there is a lot of room for air* pollution control expenditures which will result in a net economic gain to the communities and areas involved..

When I see such a disparity between damage and control costs of this magnitude, I conclude that there are facets of control which will surely yield a return to the community approximating the cost of their installation.

I don't mean that the people who spend the money will receive the benefits directly. But, although it is not usually formalized, there is a balance of assets and liabilities for every community. A city which permits its air to become polluted, its water to be contaminated, its housing to become slum, is cutting into its capital. The day will come when it will be economically downgraded.

So when I talk about the costs and benefits of air pollution control, I am not indicating to you that I believe that these have easy and obvious relationships. The things are difficult to define, and difficult to present with conviction. However, I believe that in the equitable distribution of these kinds of costs and benefits, the social sciences can make a great contribution to the solution of our community air pollution problems.

Frankly, I do not know the basis of the $65 cost figure I have presented. I have serious doubts as to its adequacy. I doubt that the *real* costs of air pollution have been given sufficient weight, because they rarely are.

Among the raw materials of man's life, air is unique. We can provide emergency water supplies. We can bring in food from new sources. We can establish crisis medical treatment. But when the air supply of a city becomes unfit for human consumption—unless you choose to walk the streets equipped as a scuba diver—evacuation is the only available course of action. Without usable air, a city dies. This is not an altogether inconceivable possibility.

I am doubtful if sufficient recognition has been given to the cost of long term or chronic effects of exposure to polluted air. The air pollution program of the Public

Health Service is relatively new, initiated in 1955, and only since 1963 with any real resources of money and authority. But we are dealing with phenomena which develop over a lifetime. Although we need to know a lot more, the evidence already in hand is damningly one-sided. The rise in emphysema and other respiratory diseases gives strong indication that sooner or later the whole population pays in health the price of dirty air.

It is difficult to talk about the social and/or economic aspects of esthetics without sounding rather woolly. What is the value of a blue sky? Of an unobstructed view of a green and rolling countryside? Or a street of trim, clean houses? What do we owe a kid who grows up in a soot-gray world where, with every energetic breath, he pumps dirt and noxious gases into his lungs? Physically and emotionally we are damaging that child.

You can survey a neighborhood and come up with a pretty good figure on the cost of paint damage. But what is the cost of creating neighborhoods where keeping a house freshly painted is too discouraging and too expensive to be worthwhile?

You may tell me that we can't include the cost of these kinds of damage and degradation because they're intangible. And I reply that, intangible or not, they are real. If we do not work to place some sort of values on them, we are just avoiding the hard questions.

There is evidence that industry is coming around to the view that it, too, has a vital stake in cleaning up our environment. I have said some harsh things in the past about what industry is doing, or, more accurately, is not doing, in the fight to clean the air and water, as the record of the hearings held by our Subcommittee will show. But I read a speech by the president of the U.S. Chamber of Commerce which can give all of us great hope for a more enlightened approach to this problem by industry. Mr. M. A. Wright, chairman of the board of Humble Oil, called on industry to take a leading role in the fight against air and water pollution and to do it now. Let me quote briefly from his address: "Either we voluntarily implement effective pollution abatement programs at all levels of business and industry, or in the near future our actions in this area will be spelled out by Congressional legislation. Today we still have the freedom to make a reasoned and resolute response to the problem. Tomorrow our actions may be tightly controlled by government regulation. If our efforts are made mandatory, not only will we be forced to take more costly and less efficient action, but we will also forfeit our claim to being a responsible segment of society. To those who say they cannot afford to take effective antipollution measures, I can only respond that they can't afford not to."

I have attempted today to emphasize my judgment—which, I believe, is widely shared—of the importance, the uniqueness, and the imperativeness of attacking our national air pollution problem.

Obviously, I cannot speak for the next Congress or for those which will come after. All I can do is attempt to anticipate their conclusions.

I shall be greatly surprised if the Clean Air Act of 1963 is not eventually recognized as only an early step in a sequence of Federal actions concerned with and contributing to the solution of air pollution problems. I am sure that this will come about. The Federal Government and the Congress have an imperfect, but nonetheless great, tradition of rising to the defense of our natural wonders and resources. I cannot believe that we will continue to permit our air—the envelope in which we live and an essential component of every productive process—to be appropriated for private use without regard for the public welfare. This is what happens when industrial or governmental operations, commuting patterns, or residential burning practices foul the atmosphere of a community. Its people pay in damaged property, health, and sensibilities the cost of clean air—without receiving it.

Once we said, "Smoking chimneys mean prosperity." But today in our prosperous and technically advanced culture, a community living under uncontrolled plumes of airborne waste is flying the pennants of poverty. They proclaim a second class city—unpleasant, unhealthy, expensive.

I have tried to indicate to you today some of the air pollution interests and concerns of the Congress in the areas of the social sciences. As we act, and I am sure that we will act, we will be guided by all available health, economic and social information.

In the Harvard Business Review, it was recently estimated that at least $275 billion will be required over the next 34 years to ensure the availability of clean air and water. Let me repeat: $275 billion dollars. That's a lot of money by any standard of measurement, war or no war. The public must understand that a great deal of that money is going to come out of its pockets, directly or indirectly. Is the public willing to pay for clean air and if so, how much and for how clean?

I don't have to remind anybody here that air pollution is a growing menace which must be fought now with dedication and urgency. All of you here know this—since this is what this conference is about. The urgency of the problem was brought home to me by a film which I previewed last night entitled "Beware the Wind." This program was produced for television by the Airlie Foundation and financed in part by a grant from the National Center for Air Pollution Control of the U.S. Public Health Service. I am told that this film will be distributed to the major television markets for showing in prime time and will be co-sponsored by professional organizations. Outstanding citizens will participate in an eight minute "open end" discussion of the air pollution problems as they relate to their own communities. Programs of this type are needed to motivate our people at both the professional and lay levels. I hope many such efforts will be made to utilize mass media techniques effectively until people become aware of what is happening to their precious environment.

Let me conclude by saying that I believe the public does want cleaner air, just as it wants cleaner environment. All segments of our society must join in that effort, and the best interests of the public will be served if we quit looking for heroes and villains.

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QUESTIONS AND COMMENTS

DANIEL W. CANNON (*Policy Executive, National Association of Manufacturers, New York City*): In my opinion, Dr. Mills' proposal is highly theoretical and, even if it could be made practical, would still be undesirable from the standpoint of effective air pollution control. I will pass over quickly the points that it would involve a highly conjectural cost-benefit analysis, that it would take years to accomplish, and that it would require a veritable Solomon to apply equitably. An even more important point is its effect on industrial plans for capital investments in control facilities.

New industrial plants are being designed and engineered from the drawing board to the construction site in such fashion as to incorporate the best available control facilities. This involves long-range planning of large-scale capital investments. An effluent-fee system would cloud the planning picture by introducing the option of paying a periodic effluent-fee rather than making part or all of the capital investment. The effluent-fee proposal should be rejected. This is a plea not to disrupt long-range capital investment planning by introducing this negative consideration. Much tougher problems are involved in old, obsolescent, marginally-economic industrial plants.

Professor Mills' objections to a payment policy are fallacious. Decisions to install or not to install control facilities often hang in the balance on the question of cost. Dr. Mills' assertion that "to reduce the cost of such an item cannot possibly induce a firm to install it" is incorrect. On the other hand, to avoid capital investment by paying the fee could be merely hiding from the hard decision that has to be made in actual cases, namely, that in the light of air pollution and other problems, in combination with lack of profitability, a certain plant should be closed. A fee-payment policy in such cases could help to achieve air pollution control and avoid economic dislocation at the same time.

Accelerated amortization of such investments without loss of the investment credit would be a much more desirable policy than an effluent-fee system. The effluent-fee system would be an unmanageable, uneconomic, and negative approach which would be a license to pollute, no matter how unpalatable the phrase may be.

I appreciate Professor Wolozin's observation that industrial companies can be good corporate citizens, but I believe that his suggestion for government participation in management affairs would be undesirable and foreign to the system which gave us the strongest economy in the world.

MILLS: As I understand it, there are three issues. One is that the use of the effluent-fee scheme would require cost-benefit analyses. The reply to that is that the use of any abatement scheme that's going to do the job it should do must be based on cost-benefit analysis. An effluent-fee scheme no more requires cost-benefit analysis than does any other scheme. If one doesn't make the appropriate calculations of costs and benefits, one doesn't know how much to abate by any mechanism whatsoever.

The second point is that effluent fees would affect investment. If they didn't, there would be no point in having them. Of course, they would affect investment; that's the whole purpose of them. The whole purpose of any scheme to abate air pollution is to affect investment, to cause some investment not to be made when it otherwise would have been, and to cause others to be made when they otherwise would not have been made. That's the whole purpose of air pollution control. If you don't affect investment, you're not going to control air pollution.

The statement that you should not have effluent-fee schemes because they would affect investments is equivalent to stating that you should not have any air pollution control scheme at all.

Mr. Cannon also commented on Professor Wolozin's thesis. It is interesting that the National Association of Manufacturers and Professor Wolozin find themselves on the same side in this issue because, if one were to accept Professor Wolozin's thesis about the irrationality and unpredictability of American business people, their inability to use an effluent-fee scheme would be the smallest part of the implications of that. The broader implication is that one could not trust private business to run the economy at all. It seems to me that business people are intelligent and do know what they're about. Indeed, better than most Government officials do. Having been a government official but never having been a businessman, I should be permitted to say this.

WOLOZIN: I wasn't going to comment, but I suppose I may as well. I was a corporate economist and I was a Government official and I still am a professor. I think we can get awfully ideological about these discussions. The point of the matter is that we do not have either the NAM-model economy nor Professor Mills' model. We have a mixed system and the tougher the problems the more of a mixed system it becomes. We have a lot of ad hoc planning all the time; we are always planning. Businesses plan and Congressional committees make them plan. All I am asking for is a longer-run integrated systematic cooperation between government and business and university academicians. I offered the example of France; I could have talked about England, Sweden, or Germany. As soon as anyone mentions that government is interfering with business, the red flag goes up, blood pressure goes up. The truth of the matter is that what I'm calling for is cooperation between business and government. If you want to call that a planned economy, I am for it.

CHRIS LANDMANN (*Manager, Engineering Services, Daimler-Benz, New York City*): I will comment primarily on points raised by Mr. Edelman but also on some raised by Mr. Phillips. I believe first of all that we should distinguish between actual control programs and those activities being undertaken at the present time by the States in order to explore the situation in their own atmosphere. I'm talking primarily now, of course, about motor vehicles. I think it is very important to make this distinction. The States have been called upon by the Department of Health, Education, and Welfare, Mr. Griswold primarily, in many addresses, to make such investigations in order to bring to the attention of the Federal Government their particular problems, to state them in such a way, with the necessary evidence, that Federal policy and Federal rule-making can be based upon them. This is an activity which I think every State has every right to engage in.

There is one point which I as a member of the industry, believe will create difficulties, possibly problems, which we must learn to surmount in the near future and which I would request Mr. Edelman and Mr. Phillips to address themselves to and answer. That is surveillance and control at the State or local level. We have a Transportation Act now that requires surveillance by the States. It requires the States to regulate and to have annual inspections or some similar system. The Federal air pollution standards are based, as were the original California standards, on a statistical evaluation of the vehicles and of the engines manufactured for new cars. The inspection, however, must be of individual vehicles, whether new or used, and is not on a statistical basis. If you want to be able to say that this car passes or it does not pass, you must have a value to be able to assign to a single car, not to a group of cars. I would like to ask Mr. Phillips and Mr. Edelman whether they would want to comment on how we will resolve this problem, possibly with the standards in mind as they are to be modified for 1970.

PHILLIPS: You have posed a problem that is of concern to us all. It is quite obvious that on an internal combustion engine you do have problems as to manufacturing costs, as to setting up the actual approach to inspection, and as to the technical development of a type of testing equipment that can be manned inexpensively. There are ways of doing this that we've discussed, whereby you could combine the annual pollution inspection with the safety inspection. This, I feel, would be a very logical approach. But standards are going to have to be set whereby an automobile is brought to the point of efficiency, at least to the fullest extent possible with the available machinery. In California, we recognized the fact that you can't very well design devices such as exhaust controls, blowby controls, etc., with primary concern for the older cars that are few in number and will eventually eliminate themselves, by accidents, by attrition, or by just becoming completely unsalable. Any program will have to be logical and one that we can live with, one that is not going to penalize the industry itself.

For the long run, we must concern ourselves with the ultimate efficiency of the vehicle itself and keep in mind that there are other power sources for that vehicle which may commend themselves such as nuclear or other fuel cells, or the utilization of electric motors on all four wheels for power purposes as well as for braking. There are many ways of reaching our objective, but I believe the industry itself is going to have to find them. And I believe the industry will, if governmental attitudes at the Federal, State and local levels are kept on a proper basis.

EDELMAN: I have a long-standing agreement with the Public Health Service experts and they with me. I have agreed not to practice engineering and they have agreed not to practice law. From a purely nontechnical point of view, Mr. Landmann, and from a logical point of view, I would suggest that if what we're coming to is an inspection system which will determine on a vehicle-by-vehicle basis whether the vehicle complies, I would think that in order to make it effective, you would have to have standards too on a vehicle-by-vehicle basis. If you have a statistical basis for determining compliance, the job of testing is going to be a difficult one. But if you have a Federal standard, which is applicable to an individual car, any car can easily, simply, and economically be tested on an annual basis by every State in the union to determine whether or not that particular vehicle does in fact comply with a specific standard.

LANDMANN: The present standard is a statistical standard, but the States are called upon to enforce or inspect on an individual basis. There is no way of making these two meet.

EDELMAN: I would just like to suggest that under the Federal regulations we have a 50,000-mile performance standard which the car must meet. I think it's inaccurate to speak about these devices being worthless after 10 or 20,000 miles. Our hope is that the device will be effective during the life of the car, which we now estimate is 100,000 miles, and should not require replacement of any kind if the car is operated properly.

LINSKY: I want to address myself to the question of effluent tax as discussed by Dr. Mills, Mr. Edelman, and Dr. Wolozin. I find myself somewhat in the position of Congressman Fogarty. It isn't very often that I have a bed-fellow position on some significant point with the National Association of Manufacturers. I'm neither employed by them nor am I a member, but on rare occasions, and this is one of them, we find ourselves in agreement. The effluent tax is a very interesting academic exercise. It is an intellectual fun-game that could be almost as enjoyable as Monopoly, if so treated.

Let me give you some illuminating figures on one of the large sources of air pollution, the power-generating station. The best air pollution control equipment now available, installed on power-generating plants using coal, costs less than 1 percent of the price of electricity as paid for by the householder. For a $10 electricity bill, the air pollution control equipment costs less than 7¢. If we double that cost so that the air pollution control equipment is twice as good as anything now being bought, this would add another 7¢ a month to that $10. We now have a price to the customer of $10.07 a month.

But let us suppose that the effluent-tax provision is in effect. Then, if the utility decides not to go to the trouble of engineering and shoehorning in any additional air pollution control equipment, it would instead pay the effluent tax of 7¢. The customer would now be paying $10.07 for his electricity and he still would be getting the air pollution malefits of the uncontrolled or semicontrolled power-generating station. I submit that this is not equitable.

MILLS: This is the only valid criticism that's been made of the effluent fee this afternoon. It makes me stop and think. This issue has to do with what the effect of an effluent fee would be in a regulated industry where the industry has, within limits, a guaranteed rate of return on its investment. I have a feeling that many public utilities are not insensitive to small savings in costs. For example, they very often use residual fuel oil rather than some low-sulfur-content fuel in order to save a little bit of money and I assume they could be induced to reverse this process if that saving were to evaporate.

However, I think there is a difficulty here which arises from the fact that a public utility has a more or less guaranteed rate of return. That permits management, if it is not really acting in the interests of stockholders within the limits of the regulatory constraints placed upon it, to just pass the extra costs on. I don't know whether or not the regulatory process could be effective in forcing management to adopt reasonable abatement schemes but, if cleaner air does have to be achieved through a regulatory process, why have the effluent-tax scheme anyway? I think this is a very real question, and I'm not sure where I would stand on this issue. As for the question of whether it's fair to make the consumer pay for devices necessary to prevent the generation of electricity from polluting the air, I think it certainly *is* fair. I can't imagine a fairer place to put the burden.

WOLOZIN: I think Professor Mills knows very well that public utilities are quasi-monopolies and they are controlled for the very reason that they are to some extent monopolies and have the power to pass on or not to pass on to the consumer any increased costs. This is to a greater or lesser degree applicable to all of the industries and businesses which I grouped under greater or lesser degrees of oligopoly. As long as competition is imperfect, we do not know whether a business will act like the utility and pass the cost on, or act like Professor Mills' model of free competition. His reasoning, therefore, blankets in a large percentage of American industry and one would therefore conclude that he indeed has to think his expressed views over very seriously.

". . . economist and author . . . university professor . . ."

ECONOMIC AND SOCIAL ASPECTS OF AIR POLLUTION CONTROL—A REVIEW

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A. C. Pigou, a noted English economist writing during the early part of this century, defined economic welfare as "that part of social welfare that could be brought directly or indirectly into relation with the measuring rod of money." [1] Ignoring the problems of adequately defining the concept of welfare, and assuming for our purposes today, though Pigou did not, that economic welfare is additive to general welfare, we may say that economic welfare is related to the satisfaction received by individuals from the buying and selling of goods and services. In most circumstances there is a money price attached to these goods and services, the price being determined by the interaction of supply and demand in the market place. Occasionally, however, and increasingly more so as our society becomes more urbanized, economic welfare becomes a function of goods and services which are not "traded via the market place." These direct effects on welfare, economists have called externalities, in part because they are external to the market mechanism.

The economic and social problems associated with the control of air pollution are a classic example of externalities—few students have taken an elementary economics course without having been exposed to a discussion concerning the problems associated with the smoking chimney. As a classic problem in applied welfare economics, air pollution control provides an issue on which the welfare economist and econometrician may combine their talents. The welfare economist, being concerned with such things as the optimum allocation of resources, asks, "What is the optimum amount of air pollution for a given community?" Alternatively, "What level of pollution is necessary if, assuming all other sectors of the economy are organized in an optimal fashion, a change in this level will only benefit some individuals or sectors at the expense of other individuals?" Or, finally, "What is the level of pollution from which, if we move, we either expend too many or too few resources in combating it?" From the answers to such questions come such terms as social costs and benefits, corrective taxes and subsidies, all of which are theoretically measurable and to which we apply the tools of the econometrician.

Even in posing these questions I have undoubtedly raised the ire of those who, like one practitioner I met, think only in terms of "forcing those businessmen to emit no pollutants." Surely, with all the recent discussions on the Nation's choice between guns and butter, we should expect similar reasoning to filter down to the pollution problem. I suspect that the engineers participating on other panels in this conference are saying that the control of air pollution is no longer a technical problem, but an economic and political one.

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[1] A. C. Pigou: Economics of Welfare, 4th Edition, Macmillan.

If this statement accurately describes the state of pollution-abatement technology, and I believe it does, then, just as practitioners know about filters, scrubbers, temperature inversions, and the like, they now need to learn about benefit-cost ratios, marginal-social-costs equal marginal-social-benefit rules, optimal taxes, etc.

I do not mean to deprecate the magnitude of the pollution problem with these remarks. I am simply trying to place the problem within the framework of economic analysis. Because pollution may result in poor health and loss of life, people tend to shun the "cold economic analysis," but I suggest that many problems have this characteristic to which we apply economic theory in a supposedly acceptable way. To name just a few—construction of freeways (which are not accident-proof), flood control, and insurance.

Perhaps the most common objection to applying economic principles to air pollution is the fact of its "external" nature. I shall return to this later, but let me indicate now that auto accidents, airplane crashes, etc., are also external in nature.

Let me now turn to a discussion of the papers presented at this panel. Professor Kneese's well-reasoned paper makes a significant contribution by emphasizing the type of economic variables we should be interested in. Not only does he correctly debunk the national estimates of the cost of air pollution by showing the deficiencies in the methodology used, but he also questions the very purpose of such estimates even if they had been derived more carefully. He argues that what is needed in this area is not more carefully derived national cost figures, but rigorous cost-benefit studies for given airsheds.

Allow me to re-emphasize a point implicit in Kneese's paper: for a community experiencing air pollution a maximum in social welfare is obtained from its limited economic resources when the level of pollution which is allowed to remain is that level for which the costs of further reduction would exceed the benefits. Notice that this rule defines the optimum level of pollution for a community and implies that when a community is operating efficiently some pollution may still exist. (I use "may" because it is conceivable that the first increment to pollution may give more disutility in dollars than it costs to remove. Therefore at such an optimum, pollution would be zero.) Yes, we could decrease pollution to almost zero, or even zero, if we stopped breathing and thus emitting carbon dioxide. But is it worth it? Each of us in this room could probably buy a $10,000 car if he wanted to, but given our resources and our income, we choose to drive a less expensive car and buy other things. The choice facing a given community is no different. What Kneese's paper emphasizes is that we have no data to show us how much further, if at all, we should attempt to reduce pollution.

In the final analysis, the level to which we restrict total pollution is both a political and an economic problem. To explain this statement, allow me to digress momentarily in order to discuss the dichotomy into which economics is often divided. "Positive economics" is concerned with "what is" whereas "normative economics" is concerned with "what ought to be." The former partakes of scientific inquiry, the latter of value judgments and ethics. Included in the latter is the problem of the "correct" distribution of income and benefits from government expenditure. This represents an area from which many economists excuse themselves in making "professional" comments.

It can be shown that if the welfare of individuals or groups within our society is weighed differently, almost any level of pollution can be regarded as the optimum level. An example will illustrate my point: Consider a community consisting of a homogeneous population which lives in various parts of town, so that the pollution emitted by the single industry in the community affects each resident differently. If the disutility of pollution for each individual is weighed equally, then the level of pollution which is optimal will be *A*. If the disutility of those who live closer to the polluter is weighed more heavily, another level will be optimal, perhaps *B*, where *B* is less than *A*. Conversely, *C* will be an optimal and will be greater than *A*.

Determining the optimal level of pollution is then in part a political problem: what weight should we attach to the welfare of different groups within the community? At this juncture we get into problems of optimal voting procedures, lobbying, and the like, topics which cannot be taken up at this time.

Dr. Smith places emphasis upon the esthetic aspects of air pollution in his paper and he despairs at the difficulties of measuring the dollar value of such losses. His paper may be interpreted as an attempt to weigh some costs of air pollution more heavily, lobbying in favor of esthetic values if you like, thus indicating that pollution should be reduced further than those not emphasizing this factor. As Kneese's paper indicates, and as my colleague, Robert Strotz, has recently shown, insofar as esthetic considerations enter into economic welfare, their dollar value can be measured in the all-inclusive measure of changes in property values. The despair comes from the difficulties in measuring these changes with the econometrician's tools, not with the theory.

I interpret McGrath's and Mills' papers as asking, "Given that the optimum level of pollution has been determined, how do we effect this optimum?" McGrath concentrates on what I would term long-run solutions, and, while they would have no effect in controlling pollution from existing sources, they may contribute to decreasing the growth of pollution in a particular area. I would emphasize, however, that such effects would appear to be greater for smaller communities where a single, newly misplaced industry would have considerable impact upon pollution levels. Given my understanding of the larger metropolitan areas and their pollution problems, I think that such planning would have little effect in areas like Chicago and New York. Furthermore, it is not obvious to me whether it is better to spread out polluters or bunch them together. Unless firms actually decrease their pollution, some areas will be polluted. Although there is an implication in McGrath's paper that we could pollute the countryside and less populated areas, it may well be better to put new polluters with the old polluters. This, in effect, would add some degree of certainty to just where the polluted areas in a city were and also leave the rest of the region free of threat of pollution. This would have significant effects on the development of the city by removing some uncertainty and decreasing complaints and lawsuits between property owners and new polluters.

Mr. Mills' paper outlines the most fruitful avenues for solving immediate as well as long-run pollution problems. In order to discuss Mills' contribution, allow me to introduce a slightly different concept from that introduced by Kneese. Rather than measure the control of pollution on the x-axis, I wish to measure the amount of pollution; consequently, my diagram is the mirror image of his. For example, my x_2 is identical to his and represents a Pareto optima for a given distribution of income (benefits).

The marginal benefit curve represents the net benefits obtained by polluters from being able to pollute. Alternatively, it represents the total benefits of being able to use one factor of production, the atmosphere, at a zero price. Economic theory tells us that the polluter will emit x_1 pollution, the point where MB bisects the pollution axis. The incremental damage function represents the weighted sum of disutility in dollar terms of various pollution levels. As in Kneese's diagram, the areas under the curves measure total benefits and damages.

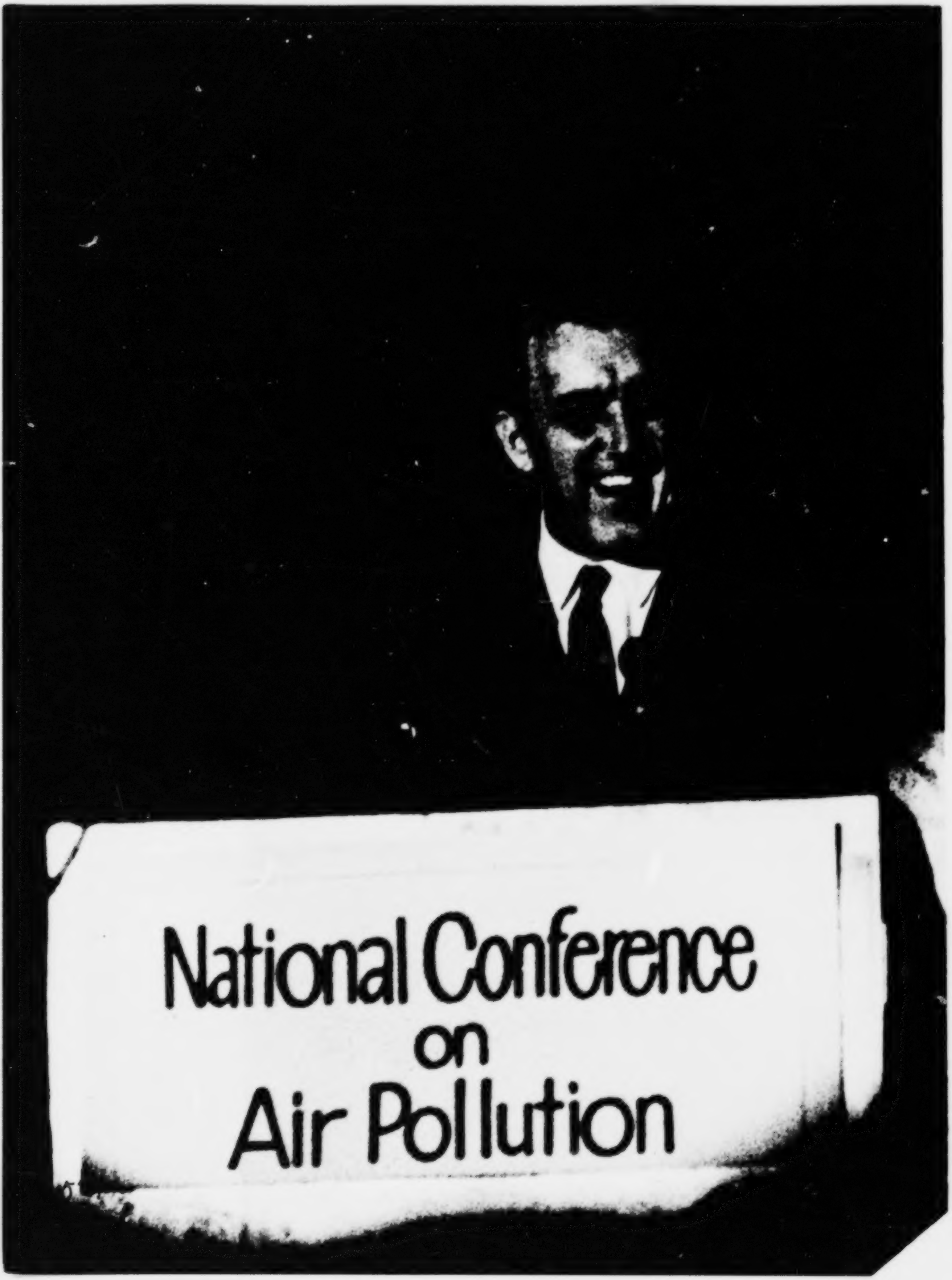
What we in effect do is confront the polluter with a price for using the atmosphere which reflects its costs to society. Rather than charge polluters, we may pay polluters for not polluting, which is really the converse of taxing them for polluting.

As Mills points out for those abatement devices that are not connected in the production of goods, a proportional tax credit on such expenditures simply will not work. What society needs to do is to actually buy the machine and continue to induce the polluter to decrease pollution as long as the marginal benefit is greater than marginal cost.

The remainder of Mills' discussion is related to the strengths and weaknesses of effluent fees versus enforcement of standards. I would agree that selective abatement might well result in the minimum cost of obtaining a given level of pollution and would be the most efficient. This is the aspect that both of us as economists are most concerned with, but I think the political implications of such a measure, if charges are used, would be insurmountable. On the feasibility criterion, such a selective process implies the use of payments—which is another method fraught with political problems.

I would also take issue with Mills' claim that effluent fees provide continuing incentives to minimize cost of abatement while enforcement does not. If the enforcement is so specific as to require the use of a certain abatement device, then I agree, but if the firm is restricted only in the amount of pollution it can emit, then a continual search must be made for the minimum cost of accomplishing this.

In conclusion, I would like to reiterate Mill's plea for imagination and experimentation in control techniques and, unlike Wolozin, would declare more faith in the power of economic incentives to control pollution.


National Conference
on
Air Pollution

December 13, 1966

BANQUET SESSION

Toastmaster John Charles Daly
Moderator, "What's My Line"
CBS–TV

Setting Goals for Clean Air
Edmund S. Muskie

SETTING GOALS FOR CLEAN AIR

EDMUND S. MUSKIE
U.S. Senator from Maine

This is an important conference on one of the most serious domestic crises we face. You represent the most important group concerned with the problem of air pollution. What politician who has ideas and proposals on the subject could ask for more in the way of a platform or an audience? The program of the conference is overwhelming.

Some of you, especially if you are the only representative of an organization, may have developed an advanced case of schizophrenia in attempting to decide which panel session to attend. On the other hand, we may ask: Who is minding the store for any organizations well enough represented to assign a delegate to each panel session?

The breadth and complexity of today's panel discussions are symptoms of our problem and its challenge to our society. We cannot, short of calling a halt to our modern, technological, industrial society, provide a simple direct and complete answer to the problem of man-made pollution. In addition, we have not developed an adequate focus for our air pollution abatement goals, programs and institutions.

Today's meetings are a tribute to our concern and the organizational skills of the Department of Health, Education, and Welfare. The state of tomorrow's world will determine whether we deserve a tribute for our ability to apply what we learned here.

You do not need from me a technical analysis of air pollution and how to reduce it. My concern is with our point of view, with the way we approach the problem. The time has come for us to take a new look at our air pollution control policies.

We have the same relationship to air that a fish has to water. A fish in a stream cannot avoid the pollution in that stream, although we may. By the same token, unless we want to wear gas masks, we cannot avoid the air around us. The next time you fly along the eastern seaboard, for example, notice the brown "smaze" which lies below you. Then remember that when you land you will have to breathe that contaminated air.

It is, quite simply, a case of survival. Whether we are hit by disastrous smogs or not, we are exposed day after day to the insidious threats of air pollution. We cannot escape them, and the increasing weight of medical evidence demonstrates the harmful effects of the air we breathe.

Air pollution control costs money—but so does air pollution.

Air pollution control may cost jobs—but so does air pollution.

Air pollution control may disrupt certain industries—but air pollution disrupts and destroys lives.

More and more Americans are willing to pay the cost of controlling pollution rather than suffer the penalty of inaction. We must decide how best to pay the cost of control and how best to organize our efforts. And those decisions will depend on how we define our goals.

To date we have set limited goals for ourselves. We have focused on individual pollutants, their weight, their amount, and their immediate and observable effect. We have considered specific emission standards to control individual sources of contamination. We have passed ordinances to reduce smoke; we have planned limitations on sulfur content in fuels used in certain cities; we have taken abatement action against specific polluters.

These were necessary first steps, but they are not adequate for an effective campaign to improve the quality of our air. The American people are not really concerned about the source or the composition of dirty air. They want clean air. The American people do not care about the statistical analyses describing health effects from specific pollutants. But they do not want to die or suffer from dirty air. The American people want to be assured of an adequate supply of breathable, healthful air. And they have a right to it.

All of this suggests to me that those of us who deal with this problem as representatives of the people should direct our attention to a concept of air quality. We need to set a national clean air goal which says that, as far as it is within our control, no emissions will be permitted which cause the quality of air to deteriorate below acceptable health standards.

What this suggests is that we no longer limit our efforts by trying simply to set emission standards on a plant-by-plant basis, hoping that the net result will be reduced air pollution.

This will require a reorientation of our efforts. Frankly, I think one of the shortcomings of our air pollution control program to date has been our failure to move ahead on the development of ambient air quality criteria. Such criteria need to go beyond questions of clinical injury or gross insults from specific pollutants. They need to include considerations of subtle, long-term effects of pollutants on our health and well-being.

Dr. René Dubos has defined health as “the extent to which the individual and the social body maintain in readiness the resources to meet the exigencies of the future.” In other words, it is not enough to consider pollution which may put us in the hospital today. We need to prevent pollution which may reduce our ability to resist disease or injury tomorrow.

Today's pollution control philosophy does not meet that test. The criteria I have suggested would meet the test, but they would be difficult to achieve. However, I am sure that we are all well aware of the right of the American people to breathe without concern for the effect of each breath on their life span. Further, if we continue today's type of attack on pollution, I do not think that we can expect to slow down air pollution, much less to clean up air.

As an example of this, it is well accepted that—necessary as they are to halt the rise in automotive pollution—the standards for automobile emissions to go in effect nationally with 1968 cars will not effectively reduce automotive air pollution below its present levels because of the rapid expansion in the number of automobiles on American roads.

With the exception of moving sources of pollution (for example, automobiles), I do not favor fixed national emission standards for individual sources of pollution. We *do* need national ambient air quality criteria, applied as standards on a regional basis. The Federal Government is the logical entity to develop the criteria, with the cooperation of public and private groups. Those criteria must take into account health, esthetics, conservation of natural resources and the protection of public and private property. The criteria must be modified, as our knowledge expands, to provide added protection against unforeseen pollution hazards. The ultimate goal should be to approach a level at which man will have to cope with little more than the “natural background level” of pollution.

But setting criteria will not be enough. They must be applied effectively, and implemented through the enforcement of emission standards. This problem is not unlike the one we have faced in water pollution. In that instance we have established a policy of setting standards on river basins or watersheds. In the case of air pollution we need to apply air quality standards in meteorological airsheds.

Community or State jurisdictions bear little or no relationship to the geographic spread of air pollution. Because metropolitan areas are not consistent with meteorological areas, the old institutional arrangements for air pollution control are not really adequate to the task. In most cases air pollution problems involve more than one State. Therefore, institutions capable of operating effectively across State lines must be developed.

The philosophy of the Clean Air Act of 1963 was designed to encourage State, regional and local programs to control and abate pollution, while spelling out the authority of the National Government to step into interstate situations with effective enforcement authority. This approach was taken because: (1) the Congress wished to help preserve the Federal system by supporting effective, viable action at all three levels of government; and (2) the Congress recognized the task of implementing and enforcing the clean air program as so enormous that it would be helpful to have effective agencies at the State and local level to get the job done more quickly and thoroughly.

As I have noted, there are serious obstacles to effective programs when we rely on traditional jurisdictions. These obstacles are compounded in interstate situations. Therefore, we need to give serious thought to developing effective regional institutions which overcome the limitations of present arrangements.

For thirty years the federally authorized interstate compact has been proposed as the mechanism for dealing with interstate problems. It has been a successful tool in some cases, but it has some drawbacks:

1. It is based primarily on State-to-State and State-to-Federal relationships. It does not give adequate weight to local or metropolitan area participation in planning or implementing decisions.

2. It does not usually develop an adequate enforcement mechanism, particularly when one or more States think their own specific interests may be involved.

3. The traditional interstate compact has not given sufficient attention to the changing requirements of a complex modern society. It has not been flexible enough to deal with changing concepts of pollution control or the interrelationship of transportation planning, zoning and industrial development.

I believe these obstacles can be overcome. We are experimenting with new approaches to similar problems under the Water Quality Act of 1965, the Water Pollution Control Act Amendments of 1966, and the Demonstration Cities and Metropolitan Development Act of 1966.

The real answer must come from State and local governments who must subordinate their own narrow prerogatives in the interest of improving the quality of the environment.

There will be a temptation in some areas to let narrow economic interests prevail—to steal industries from areas of vigorous air quality control, to go easy on existing plants, whatever the impact on the public health or welfare, to avoid short-term economic problems.

But if the State and local governments take this short-sighted view, if they fail to establish and implement effective regional programs, the Federal Government will have no alternative to enforcement action under the interstate abatement authority provided in the Clean Air Act.

No one who has studied the air pollution problem is unaware of the substantial costs of pollution control or the technological obstacles which still hamper effective control in some instances. By the same token, we recognize that there are costs in the failure to control that may affect the long-term economic vitality of an area or the Nation.

William Bousefield, writing in 1882, noted the adverse effect of air pollution on the manufacturing districts of England, particularly on the textile industry: "It is idle to expect that designers and operatives who pass their lives in scenes of gloom and ugliness can acquire the purity of taste which is necessary to render their work eminent in the markets of the world . . . our life, physical and mental, we derive from our ancestors, from our surroundings, and from our education. What, if no change is made for the better, will be that of the descendants of the thousands of operatives who live and who bring up their children entirely in these depressing and sooty fumes? There can be no doubt that a further and general deterioration of their natures will take place, which cannot fail to weaken their energy, and thus impair the national prosperity."

Bousefield's predictions have been borne out in England, and the threat continues. Indeed, we know that the effects of air pollution are even more insidious than he had realized.

And the American people are aware of it. The recent Harris poll confirms the impression that rank and file citizens are today aware of pollution, that they resent it, and that they want something done about it. There is, on the issue of pollution control and abatement, a "revolution of rising expectations." Citizens are no longer willing to accept the cliche that foul industrial odors represent "the smell of money." This is a fact which public officials and business leaders must reckon with. If we do not make meaningful progress toward the improvement of air quality, public demands may impose on all of us more than we had bargained for.

It is easy to be a demagogue on the issue of air pollution. It is easy to cast stones at alleged polluters and office-holders, but the Congress has tried to avoid unreasonable demands. We have attempted, through our Subcommittee on Air and Water Pollution, to build a sound foundation for a national air quality program. That program includes research on the causes and effects of pollution, development of air quality criteria and standards, research and development of improved techniques of solving specific pollution problems, support for State, regional and local control programs, and authority for Federal enforcement in interstate pollution situations.

The suggestions I have made here represent a logical extension of our national program. We believe the program must be improved and extended. To emphasize that belief, the Subcommittee is planning hearings for February 1967 to explore further the problems and progress in control of automobile exhaust emissions. It is the Subcommittee's intention to begin in Los Angeles, where we will hear testimony on the results of the experience of the State of California on the automobile emission devices installed on 1966 model cars.

The Subcommittee plans also to go to Denver where automobile emissions contribute greatly to a serious air pollution problem. We have not yet decided on other cities which the Subcommittee will visit, but we do know that we will visit the automobile capital of the country, Detroit, to obtain progress reports from the major automobile companies.

We hope, in both Los Angeles and Detroit, to visit research and control facilities and to obtain firsthand such information as is available, so that the Congress can gain some insights as to the probable results from nationwide application of automobile exhaust controls on 1968 model cars.

In addition, we shall explore alternative sources of energy for propulsion of motor vehicles, including the battery-driven electric car.

Another aspect of the hearings will be an attempt to ascertain what types of political institutions might be developed to achieve air quality goals in intrastate and interstate areas.

I take note of these hearings to underscore the intent of the Subcommittee on Air and Water Pollution to pursue vigorously its obligation in educating both itself and the public on the problems and progress in this area.

All of us—industrial representatives, pollution control officials, civic leaders, conservationists, Federal officials, and the general public—must remind ourselves of the need to move rapidly to improve the quality of our air. Further, we must all realize that no narrow personal or private motive can be allowed to outweigh the importance of the public health and welfare of the people of the United States.

The time has come to put aside the concept of air pollution control as an adversary proceeding. All of us, whether we are plant managers or workers, corporate officers or public officials, stockholders or consumers, engineers or conservationists, must breathe the air. All of us, in one way or another, pollute that air. If we truly believe in the objectives of a democratic society and its emphasis on the worth of the individual and the right of every man to achieve his potential, we will assume our individual and collective responsibilities to reduce the threat of pollution.

Each of us may see only a part of the problem. For some it may mean harder work in researching the cause and effects of a specific pollutant. For others it may mean paying higher taxes for effective pollution control programs; for still others, it may mean giving up prerogatives in local or State governments to insure more effective controls, or reduced dividends to help pay for pollution control equipment. For all of us it may mean higher prices for products and services as part of the cost of an improved environment. But each cost will contribute to the goal of improving the general welfare.

You may remember the story of the three medieval hod carriers who were stopped by a passerby as they walked to Chartres. "What are you doing," he asked. "I am carrying stones," said the first. "I am building a wall," said the second. "I am building a cathedral," said the third. That third attitude should mark our air pollution control efforts.

As Dr. Dubos has written: "Concern for the future is the mark and the glory of the human condition. Men come and go, but however limited their individual strength, small their contribution, and short their lifespan, their efforts are never in vain because, like the runners in a race, they hand on the torch of life."

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December 14, 1966

PLENARY SESSION

REPORTS OF PANEL CHAIRMEN

Chairman Vernon G. Mackenzie
Deputy Chief, Bureau of Disease
Prevention and Environmental Control,
U.S. Public Health Service
Washington, D.C.

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A MOTOR VEHICLES

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The deliberations, questions and discussions of Panel A on the subject of Motor Vehicles, clearly supported the conclusion that motor vehicle emissions were and are key items of concern at this conference. Although the motor vehicle was defined as the principal contributor to adverse air quality, it was likewise pointed out repeatedly that other emission sources are also major contributors to the general air pollution problem and also require control.

The task of automotive emission control is formidable. This challenge involves the control of emissions not only from today's 94 million vehicles, but also from the anticipated 120 million vehicles which will be on our roads in 1980.

There are significant economic and political aspects to vehicle emission control. Apparently it is far easier to effect installation of a million dollar system on a single major source of air pollution than to convince the average motorist of the necessity of spending $50 in controlling harmful pollutants from his vehicle. The problem of controlling the nation's vehicles is a big one; it involves not only the installation of the system, but also the maintenance of the system.

A comprehensive picture of how vehicle emissions are contaminating our nation's air was presented, with special reference to California, but with an eye to the increasing problem in other areas of the country. The State of California's pioneering automotive emission control program and the engineering developments achieved by industry to control emissions indicate the successes as well as the problems in vehicle emission control.

The regional approach to emission control was emphasized and highlighted by the special difficulties represented by the metropolitan New York area.

The awakening of the people and the Federal Government to all these problems has resulted in Federal legislation requiring nationwide control of vehicle emissions.

It was re-emphasized that nationwide ambient air quality criteria or standards are needed to provide guidelines for State and local control authorities, and to permit the Federal Government to provide effective and realistic emission control standards for motor vehicles.

Existing federal automotive standards were repeatedly recognized by control officials as being insufficient to meet future needs.

The problem of meeting air quality requirements with vehicle emission control indicates that both new and used vehicles should be controlled. In reality, however, the effective emission control of used vehicles, representing the major source of emissions, poses serious technical, economic, and public acceptance problems.

Although it was acknowledged that the most effective means of achieving air quality goals would be controlling both new and used vehicles, realistically the problems of used vehicle control may be insurmountable on a national basis. In light of this, the problem of minimizing vehicular emissions depends on our success in controlling the new motor vehicle.

In considering control approaches, it appears it will not be sufficient to impose regulations on hydrocarbons and carbon monoxide alone. It will be necessary to consider the control of metallic additives to fuel and oil, oxides of nitrogen emissions, sulfur compounds, smoke, and odor. Although these factors may differ significantly in the problems they pose, they all require continued study and evaluation.

The panel emphasized that the motor vehicle of the future must cease to be a factor in adverse air quality. This goal can be accomplished only by the continued dedicated and cooperative effort of government, industry, and the car-owner.

Years of effort have resulted in the development of emission control systems which provide major reductions in automotive emissions. This achievement was possible only through development of considerable basic information on the relationships between vehicle emissions and various engine design factors. This work has been shared by government agencies, universities, and American industry. While a substantial portion of the emissions coming from the crankcase and exhaust have been controlled, greater effort will continue to be needed in the future to control other emission sources.

Experience to date indicates that some means of assured periodic maintenance of vehicles must be a part of any emission control program. This introduces new problems, such as the availability of an adequate supply of properly trained mechanics and the education of the public to the need for proper vehicle maintenance.

It is apparent that, for the foreseeable future, improvements in existing gasoline and diesel engines must be the approach to emission control. Major technical problems exist in other forms of automotive powerplants and preclude their early use.

The gas turbine appears on the horizon, however, as a future powerplant for the heavy truck industry. It probably will be limited to that use. Electric cars, powered by either batteries or fuel cells, do not appear to be a practical form of propulsion for general use until major breakthroughs have been made.

An apparent partial solution to the vehicle emission problem is the development of efficient, economic, and practical urban mass transportation. Adoption of such a system involves studies in the individual needs of our cities and the changing patterns in the growth of metropolitan areas. Any such system must reflect the people's needs and their preferences.

In conclusion, therefore, it is evident that while significant gains are being made in vehicle emission control, continued diligence and increased effort must be maintained to assure clean air for ourselves and future generations.

B

HEAT AND POWER GENERATION

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Tennessee Valley
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The development of an abundant supply of low cost energy has been an important factor in enabling our country to grow to the status it now has in the world. The United States, with 6 percent of the world's population, utilizes over one-third of the world's energy production.

Energy uses in our homes, businesses and industrial establishments now require the equivalent of 1.5 billion tons of coal per year. These uses are growing at a rate which doubles about every 25 years.

Until recently, primary reliance for energy supply to these purposes was upon the fossil fuels, with hydroelectric power providing a small fraction of the total. The advent of nuclear power within the past few years has augmented these traditional sources, and the power supply industry is incorporating nuclear power into its supply systems. In 1966, about 55 percent of new generating capacity ordered has been nuclear.

Our Nation's policy is to encourage the further development of all of our energy resources, hydroelectric, coal, gas, oil, and nuclear. Our scientists and engineers are continuing their search for more effective ways of converting these sources into useful forms. They are also actively seeking other sources of energy—such as solar energy and controlled nuclear fusion—which can be turned to man's use.

The growth in energy use will necessitate optimum development of all our energy resources, and ways must be found to assure their economic availability at the same time that we provide for cleaner air. The electric power industry as a major user of fossil fuels is also a leader in air pollution control.

The burning of our fossil fuels results in added contaminants in the air, the principal ones being particulates and the oxides of sulfur and nitrogen. The panel's discussions were concerned with these contaminants.

The technology to effect a major reduction in the rate of emission of fly ash to the atmosphere is available now. This is being accomplished by the present policy of utilities in specifying high performance collectors for new plants. It is anticipated that high efficiency collectors will also be used for new industrial coal-fired boilers.

Total fly ash production in the heat and power generation industry is expected to increase from the present rate of 23 million tons a year to about 32 million tons a year by 1980. However, by application of present technology in fly ash collecting equipment, the fly ash emission to the atmosphere is expected to decline during the same period from 6.5 million tons a year to about 3.8 million tons a year. When you compare the 3.8 with the 32 million you can see the effectiveness of the collectors.

Removal of sulfur oxides is a more difficult matter. Efforts have been directed toward the use of low sulfur fuels and to the extraction of sulfur from the fuel before it is burned, as well as to its removal from the effluent gases.

Assuring adequate supplies of low sulfur fuel for eastern power plants is more easily said than done. The availability of relatively low sulfur oils in world markets is quite limited. While there are sizable domestic reserves of low sulfur coal, they are not available where they are most needed. Only 10 percent of such known reserves are east of the Mississippi River. They are "coking" coals, needed for metallurgical purposes, and are not available for generating electric power. While gas can serve as a clean fuel in electric power generation, there are many competing demands for it, both as a fuel and as a chemical, in addition to the use for air pollution control. It appears that if it is to be used it will probably be in very special cases.

Taking sulfur out of the fuel before it is burned has met a formidable cost barrier. Known methods for desulfurizing residual fuel oil would add 10 to 40 percent to the cost. Getting rid of sulfur in coal also presents a problem. We know of no way of removing it in its so-called "organic" forms. Present methods for accomplishing removal in its pyritic form are both costly and inefficient. It is doubtful that these methods can solve the problem in the large volume utility markets.

Prospects as to economic removal of the sulfur compounds from the effluent gases have so far not proved very encouraging. Nevertheless, somewhat higher hopes for a breakthrough lie in this direction as evidenced by the increasing research being conducted in a number of countries by public and private agencies.

Among the processes under active investigation is the direct conversion of sulfur dioxide to acid at a project in Pennsylvania jointly financed by Metropolitan Edison Company and the Monsanto Chemical Company. An "alkalized alumina" process which would produce sulfur, developed by the Bureau of Mines and funded by the Public Health Service, will move from the pilot scale to an intermediate scale in 1967.

A manganese oxide process to produce either gypsum or ammonium sulfate as products is being investigated in Japan.

Research on limestone processes for collection of sulfur dioxide is under way in nine laboratories in Germany, Japan, and the United States. A concerted cooperative effort by several industrial and governmental research groups in the United States is underway to evaluate these processes.

Char sorption is being evaluated in Germany on large-scale equipment.

Increased demand for energy and the necessity to provide economic alternatives require the development of new processes for sulfur control. For the immediate future, primary needs are: (1) to promote increased application of methods presently available for control of sulfur dioxide and (2) to develop the most promising processes to assure that methods are available for control of as many of the different sources of sulfur oxide pollution as possible. But in addition we should be working now to develop totally new concepts which eliminate the factors that limit the economic capacities of presently known processes.

Oxides of nitrogen have been of concern in special situations where there has been an opportunity for them to react with hydrocarbons. The relatively small quantity of nitrogen oxides released to the upper atmosphere from powerplant stacks has not been considered a serious problem. Perhaps for this reason the research effort currently devoted to the causes, effects, and methods of reduction in emission rates of nitrogen oxides is small in comparison to research in sulfur oxides.

It is suggested that research in processes for removal of sulfur oxides also be evaluated for possible reduction in nitrogen oxides. Future research should also consider the control of formation by reduction in peak flame temperatures, and decomposition of those oxides formed by slower cooling of the gases and use of surface active catalysts. There is also need for a better definition of the ambient level of nitrogen oxides that should be permissible. This is likely to vary according to the pollution characteristics of a given region.

In a sense we are fortunate that while we search for better ways to remove the pollutants, we have a tool available which has proved effective and economical in reducing ground-level air pollution. Today almost every major powerplant being designed to burn fossil fuel includes a stack with sufficient height to keep ground-level pollution within acceptable limits. When located in open terrain, high stacks produce a dramatic reduction in local concentrations. They also convert the least favorable meteorological conditions of a ground-based inversion into the most favorable by establishing the plume in the upper part of a stable layer.

There is still more to be learned concerning the usefulness of high stacks. Complete cooperation and the exchange of significant data among all affected would be helpful. We must achieve a more reliable method for predicting plume rise including the multiple stack situations. It should be determined if inversion breakup fumigations for large powerplant plumes actually occur, and if so, under what conditions and how often. The behavior of large plumes should be determined with respect to low or weak inversion lids. Also, the atmospheric half-life of contaminants such as sulfur dioxide should be determined.

In seeking solutions to the problems of air pollution we need to bring to bear all our scientific and technical capabilities to develop the several alternatives. We need to analyze these alternatives from the point of view of overall benefits and overall costs. Public and private management can then choose a course of action in the interest of society.

There can be no complacency, but neither is there need for panic. Rather, there should be active pursuit through continuing and expanding research and development to utilize all our fuels without impairing our atmospheric environment.

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HUGUET
PANEL C
MICHAELS
PANEL D
FRECHETTE
PANEL E

INDUSTRIAL OPERATIONS

C

JAMES H. HUGUET
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Vice President Humphrey gave a very positive message in his opening address to this third National Conference on Air Pollution, when he said that, in order to insure clean air, we must use all our available resources in a determined coordinated effort. Mr. Humphrey went on to say that this means an active working relationship of local, State and Federal governments, as well as private industry.

The situation today shows that many industries have cooperated closely with government at all levels in controlling air pollution, and that significant progress is being made. These examples of cooperation and progress in air pollution control should serve as an incentive for those industries which have not yet taken action.

Air pollution control has been practiced in some industries for several decades before control became a national issue. However, ten to fifteen years ago, many industries used little air pollution control or used systems which were only partially effective. With the passage of the Clean Air Act of 1955 and with increased industry awareness of public concern over air conservation, a number of industries installed air pollution control devices. Some of these devices were relatively efficient, but many instances of poor service factor and decreased performance occurred. There has been, however, a steady improvement in the design and construction of control devices, and at this time there are available several types of control equipment which are highly efficient and reliable when properly designed, operated and maintained.

These control devices are being applied to industrial processes on a broader scale than ever before, but the continuing expansion of our industrial economy will require an even greater utilization of this type of equipment. Reducing the cost of basic control devices is a challenge to equipment manufacturers.

Many significant reductions in emissions have been achieved as the result of process changes and improvements. Technological changes have brought improvements in many areas. For example, in the petroleum industry the relatively recent "hydrocracking" process removes sulfur from the oil product which is burned and permits recovery of elemental sulfur and sulfuric acid. Similar changes in other industrial practices have significantly reduced or eliminated many source emissions. In fact, one speaker on our panel declared that a major portion of the success in his area in reducing industrial emissions has been due to process changes rather than to control devices.

Other outstanding examples of process change have been seen in the steel and chemical industries, where improved processes have resulted in greater output of desired products and reduced emissions of airborne contaminants. Many such modifications have resulted in lower overall cost, and this objective has been advanced to the point where air pollution control considerations are today an integral part of research and development programs on new products and processes. The increasing emphasis on air cleanliness in research and development programs will bring even greater gains in the future through this means.

Unfortunately, there are still some basic industrial operations where neither control devices nor technological improvements could be used successfully as a means of reducing air pollution. Intensified research in these areas is essential to meet the growing problem.

It is apparent from a review of the current status of air pollution controls on industrial operations that technology exists for most particulate emissions. Relatively little, and, in some cases, no technology exists for the control of gaseous emissions. Many instances of particulate controls for industrial operations were cited by industrial representatives. Available control devices installed to date have successfully removed significant amounts of particulate pollutants. Today's aroused public is demanding that the efficiency of these cleaners be improved to provide essentially non-visible plumes from stacks, or cleaned steam plumes which disappear readily.

Evidence of high maintenance costs of control facilities has been cited by industry. Maintenance costs of control facilities vary according to the type and quantity of emissions involved. However, it is being recognized and accepted that such controls usually require an upward price adjustment in the final product. The consumer appears ready to share these business costs in the interest of cleaner air for himself and the community in which he lives, works, and plays.

The investment required and increased costs of operating and maintaining control equipment do pose a problem to small industries in the United States. Many small foundry operators, for example, will find it difficult, if not impossible, to absorb required collector costs unless a breakthrough in collector technology or cupola process design brings about cost reductions. Government and/or joint government-industry-sponsored research on such problems would be most beneficial to many small industries. Some means of providing governmental financial assistance would be most helpful in developing and encouraging the installations of required equipment for these smaller industries. Legislation to provide financial incentives would be a worthwhile government contribution to the government-industry partnership of achieving clean air.

Waste products collected from central installations continue to plague industry for a disposal solution. With further knowledge and experience many of these wastes might be converted into useful and salable by-products. In many instances, these captured materials must be dumped at a location and in such a manner that they do not become airborne again, cause stream pollution, create odors or mar the landscape.

The technology for removing odors from industrial processes is, with some exceptions, generally known. The collection of odorous emissions and installation of such controls is frequently quite expensive and requires a high operating and maintenance cost. A number of industries have indicated that they are willing to make the required investments in odor control devices where these are known to meet the problem.

All segments of this conference have indicated a lack of knowledge and technology to control certain gaseous emissions. In instances where polluting elements or compounds can be removed, such practices are being employed. Industry is applying new technology as controls are devised. Industry is studying the practices of foreign firms to learn of new control measures that might be applied to domestic operations.

Industry has recognized its responsibility to provide cleaner air to the community in which it operates. It has indicated its willingness to make investments in control techniques at an advanced rate. It is further willing to consider the installation of known controls, even though these may not meet the ultimate need. In other words, if the problem can be solved with known technology, it will be solved; new and improved control practices will be added at a later date as technology advances.

This attitude is based upon the premise that, in order to have effective control, we need realistic ambient air quality criteria. The Federal Government is presently working on such criteria. Both industrial and control panel members voiced opposition to the concept of establishing uniform air quality emission standards for stationary sources.

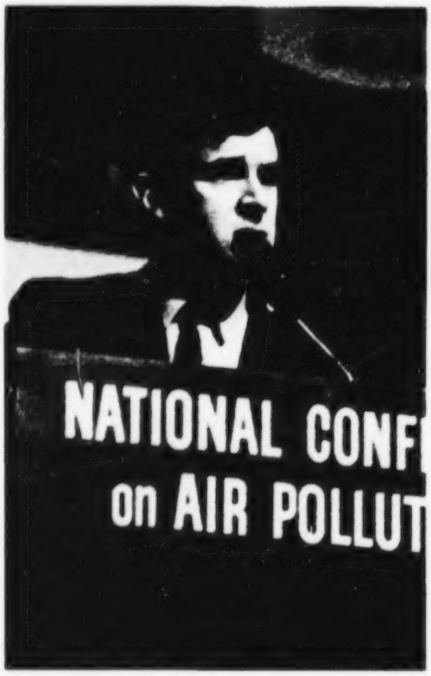
One of the most encouraging developments of the past decade has been the steadily increasing cooperation between industry and government on mutual problems of air pollution control. Industry has become keenly aware of government goals in various areas. Government has become aware of the very real problems faced by industry in striving to meet these goals. A new feeling of understanding and mutual respect has resulted in a positive approach to this problem.

This cooperation has also spread among industries. Increasingly, there has been an exchange of information between industries on designs and applications of control systems. An effective approach taken by one industry has often been found to have application to another. And, as noted above, industry is also following control developments abroad in an effort to keep abreast of the latest technology.

Further evidence of industry-government cooperation is seen in the positive relationships being developed between informed industry representatives and control agencies. As a part of this, several industry groups do an excellent job of keeping their member companies informed of trends in legislation and other developments. Two trade associations are sponsoring research on health effects of air pollutants. Both of these associations have agreed that the results of this research will not be proprietary and will be openly published when available. Qualified technical people from industry regularly confer with control agencies in an effort to work out sensible solutions to specific air pollution problems. More of this cooperation is certain to be seen.

With all the discussion, it is clear that control of industrial air pollution must, first and foremost, be at the local plant level. As Senator Boggs observed, "After all, pollution begins as a local problem and the best place to stop it is at the source." In terms of industrial air pollution, the local plant is where the problem lies, and this is where the solution must be found. This means, of course, that the local plant manager is actually in a key position, for he can best sense the needs and the remedies. But unless he is fully backed by his top management, he cannot make much progress in controlling emissions from existing plants or in requiring that new plants meet certain emission requirements.

In order to be effective, the plant manager must have technical personnel who are capable of assessing the control needs, designing the systems, coordinating and constructing and directing the start-up of these facilities. There must also be access to the research and development department for development of improved methods when necessary, while research and development must have a well-defined responsibility to consider air pollution control as a process requirement in new product development. The plant manager also has a direct responsibility to see that the plant is operated so as to minimize emissions and maintain pollution control equipment in good working order. A very important part of the entire effort is that each plant manager have a technically trained employee to coordinate the air conservation program.



The plant manager or his designated representative also plays a key role in effective relations with the community. Industrial plants are frequently charged as culprits in a community's air pollution problems. However, while a plant is often a major contributor, it is definitely not the sole offender in a community. The approach to pollution control to date has been piecemeal, directed at the easily identifiable major industrial sources. But now, the air contaminants affecting a total community are being identified—and there is a public demand for control action.

One speaker noted that his area has benefited from an advisory committee composed of representatives from industry, business, and the community, which has given excellent cooperation in attempting to find solutions to all aspects of air pollution control. This type of cooperative action is strongly urged for all communities.

The conference presentations have indicated a strong need for effective communication between the public, government, industry, and the scientific community on problems and progress in air pollution control. The Air Pollution Control Association, which is composed of members of all segments of our society, is a forum for this interchange of information. The Manufacturing Chemists Association and the American Petroleum Institute are associations which have active programs for disseminating information.

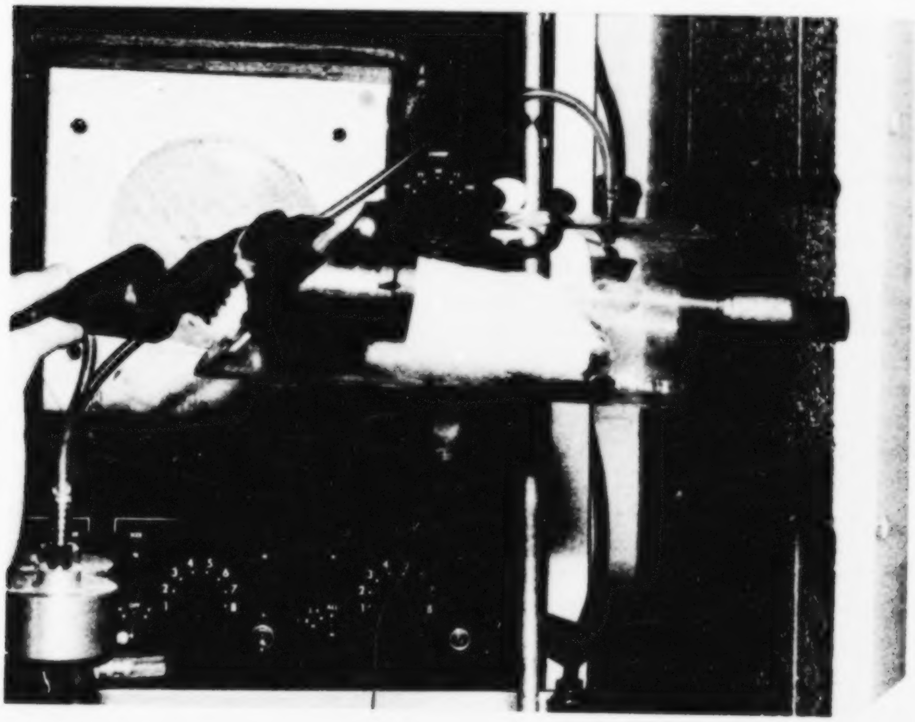
The theme of this conference is **Control Now for Clean Air.** Direct action at the local level and proper application of control measures together are bringing results. While we recognize and accept the imperative of the "Now" in the theme, we also recognize and accept the fact stressed in so many of the papers in our panel discussion—that time is an inevitable ingredient of any sound plan for emissions control. As one speaker pointed out, in air pollution control in any major plant, it generally takes at least two years to perform the necessary engineering, obtain approval of financing from top management, order the necessary materials, and install the control facilities.

Therefore, we would expand the conference theme as follows:

Control *now*—where control is possible.

Plan *now*—for an integrated program of air conservation through emissions control and investigate new processes which can lead to reduced emissions.

Research *now*—where existing technology is inadequate for the task to which we are all committed.



SOLID WASTE DISPOSAL

D

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Wastes have increased rapidly in recent years as a direct consequence of the population growth and our increasing affluence. Today we generate an average of 4.5 lb. per person each day and the amount is increasing at a rate of 2 percent per year. Total refuse generation in the United States amounts to at least 160 million tons annually. It is estimated that half of all refuse is disposed of by burning in the open or by incineration; the air pollution produced represents approximately 4 percent of the total nationwide pollution or 20 percent of the particulate emissions. The remaining solid wastes are disposed of by landfilling, hog feeding, grinding, and other such methods, which contribute to land or water pollution and sometimes cause airborne odors.

The total contribution of refuse disposal to air pollution is relatively small. Yet this small contribution does not accurately reflect the significance of refuse disposal by burning to our air pollution problems. In the public mind, incineration is a problem of considerable concern. This is due in part to the fact that many incinerators are not properly managed, although generally adequate technology is available. Other types of burning cause local nuisances and esthetic problems of considerable magnitude. For these reasons, the public and their representatives have a deep concern for the impact of present solid waste disposal on the quality of the atmosphere. As Frank Stead put it: ". . . it is apparent that the significance of any activity, such as refuse disposal, on air pollution depends upon the effect one is concerned with. If the only concern is prevention of public health disasters, transportation shutdowns, property damage and chronic health impairment, then one could conclude that refuse disposal plays a relatively unimportant part in producing air pollution. If the preservation of human comfort is considered important, then disposal of refuse by conventional methods is an important contributor to air pollution."

Alternative disposal methods which do not pollute the air are available, but invariably these other methods cause other types of pollution. The chief of the PHS Office of Solid Wastes, Wesley E. Gilbertson, put it this way: "We ought to have a truism for people everywhere who are concerned about or working for improved pollution control: that a problem solved in one sector of the environment—land, air, or water—may not solve the problem nearly as much as it shifts the pollution into another sector. The time has arrived, if we are to protect and improve the health of man when we must stop shifting pollutants among sectors of the environment."

It is essential in disposing of solid wastes to recognize the pollution interrelationship of air, land, and water and the consequences of this pollution on the region affected. Alternative methods of disposal currently being studied were described by Dr. Golueke and Professor McGaughey. These include new landfilling techniques, ocean disposal, composting, wet oxidation, pyrolization, and anaerobic digestion. Except for pyrolization, these methods, if properly developed and operated, would make little contribution to air pollution. Professor Kaiser described a very high temperature "slagging" incinerator furnace which is currently being demonstrated. However, the air pollution contribution from this latter device has not yet been reported. The work currently under way may provide reasonable alternatives for refuse disposal, provided other factors such as proximity of solid wastes sources to disposal facilities and ability to dispose of or utilize the end product are resolved.

The cost-benefit equation must always be considered. At the present time, population concentration is drastically reducing the land space available for refuse disposal and increasing the importance of incineration as a primary refuse disposal method in urban areas. This need not result in meaningful contributions to air pollution, since, as Fred Rehm reported, effective municipal incinerators emit only 3 to 5 lb. of fly ash per ton of refuse, a quantity comparable to efficient oil burning and considerably below efficient industrial or coal powerplant emissions.

It is further noted that the sulfur content in today's refuse is so low that the gaseous emissions produced by good high temperature incineration contain only insignificant traces of sulfur dioxide. Unfortunately, an estimated two-thirds of all municipal incinerators and a higher percentage of industrial and other on-site incinerators are over-age, poorly designed or improperly operated. With a reasonable effort, most poor incineration can be updated, improved, or managed to meet present-day air pollution standards.

The technology is at hand which will permit present incineration to meet reduced particulate emissions. We suggest that perhaps this limit should be 0.4 lb. of particulate per 1000 lb. of gas, corrected to 12 percent CO_2 at standard conditions.

With the foregoing consideration in mind, it is evident that we should pursue the following course of action:

1. Open burning, including the use of backyard trash burners, tepee burners, single-chamber flue-fed incinerators, and burning pits, should be abolished in all but isolated rural areas.

2. Realistic incinerator air pollution regulations, based upon local requirements and desires and in accordance with national performance standards, should be established and enforced.

3. The search for simplified continuous particulate measuring instruments should be continued.

4. Training and enforcement techniques should be used to upgrade management in all aspects of solid wastes.

5. The Solid Waste Disposal Act should be amended, as suggested by Congressman Ryan, to provide: (1) Federal financial support to municipal agencies for the construction of efficient solid waste facilities; (2) financial support for the development and maintenance of effective state and local solid waste management programs, coordinated in regional approaches; (3) a system of incentives and controls to industry to cut down excess waste in packaging and finished products, including power for the Federal Government to encourage or prohibit various packaging practices; (4) as a start, funds in the order of 200 million dollars a year for construction grants and an increase in research allocations; (5) continuation of research, development, and demonstration work on new and improved refuse disposal techniques, recognizing the growth potential of a solid waste problem and the likelihood of changes in characteristics of refuse.

Consistent with our desires to keep refuse quantities down, our report is a short one.

STATE AND INTERSTATE AIR POLLUTION CONTROL PROGRAMS

E

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The panel E sessions on State and interstate air pollution control programs were characterized by excellent presentations and a large and actively participating audience. We considered first the matter of State programs and their development. Today, 25 States have some form of control program. It is apparent that the past 15 years have witnessed major growth since there was but one State program 15 years ago. This is a promising but far from satisfactory situation. Too many of the existing programs appear to be inadequate or barely adequate, and a great deal of improvement in both form and execution is required. Those States without adequate programs should establish them immediately. The panel felt that in the establishment or improvement of such programs, the broader concept of *air use management*, implying a balanced concern for the varied needs and interests of the many air users, be substituted for the more limited concept of *air pollution control*.

Development of programs in air use management should start, the panel thought, at the State level, and build both *up* to the interstate and Federal levels and *down* to the regional and municipal levels. Time is of the essence, as public opinion is aroused and the public may demand that the Federal Government involve itself to the extent of increasing its authority over the air pollution control program nationwide.

Strong arguments in favor of programs based upon State responsibility are the State agency's relative freedom from local influences and pressure groups and the State's ability, with greater financial resources, to acquire competent personnel, to purchase more effective equipment, to encourage a greater research effort, and to administer a more complete, comprehensive and sophisticated program. Any State can develop a statewide plan designed to control pollution and insure substantial uniformity of regulation and enforcement.

A recent statement at the national Governors' Conference was cited as follows:

"While the role of State government in air pollution control is acknowledged in Federal policy and by the leadership of several States, many States lack effective legislation defining the State's responsibilities and have not supported adequate administration of enforcement and abatement activities.

"The first goal of all States should be the enactment of an air pollution control statute which sets forth state policy for air pollution control, provides enabling authority for local and regional programs, and establishes a state administrative agency and program.

The second element of responsibility is for the state to establish an administrative unit with responsibilities for the control and prevention of air pollution and for research, investigation, assistance to local governments, and education."

The relationships between the various entities must be clearly established and the responsibilities carefully delineated. We believe that a varied approach to program development is both feasible and desirable. The consensus was that many routes to the same goal, that of air quality appropriate to the needs of the time and the place, are possible.

A reform suggested in our national air pollution program is the immediate development of *regional governmental authorities* to fight air pollution on the scale that it occurs.

In addition to regional air pollution control units, it was also suggested that the Federal Government be given authority to set *air quality standards* and *emission standards.*

Certain elements are essential to air use management at the state level. Enforcement procedures must be one of the keys to successful air pollution control and abatement. Society must establish that the *right to clean air* exists as a right coequal to the right of economic opportunity and the right to education. Yet no air use management program will succeed unless it encompasses prevention of new air pollution; unless it provides for consideration and encouragement of new developments in community growth patterns, in energy utilization, and process alteration. Economic incentives must be added to punitive and injunctive control procedures. While the injunctive route of enforcement appears to offer the best present opportunity, there is great need to find speedier and more effective, yet no less equitable alternatives.

The citizen must become knowledgeable in air pollution control and air use management. The citizen must make his wishes and views known to elected officials, control officials, industry and to the public at large. There is need for a far greater involvement of the general public if there is to be an effective attack on air pollution.

Several panelists found, with regret, that at present we lack one essential cornerstone to the successful development and prosecution of air use management programs at any level of government. Intelligent, equitable, economic and uniform air management must ultimately be based upon soundly established *air quality criteria.* We believe strongly that the Public Health Service should produce such criteria at the earliest possible moment.

At the State and local level, the National Center for air pollution control of the Public Health Service has been active and helpful in suggesting ambient air criteria, but as yet no criteria have been established at the national level. It is completely unreasonable for the States to attempt to make these decisions on criteria when they do not have the extensive literature resources, the large medical staffs, nor the time to interpret this information as it relates to effects on health. Public pronouncements have been made concerning the danger of pollution to health, but little has been established as to what criteria are acceptable for any pollutant.

Criteria when first presented may seem impossible to meet in the light of present economic and control technology, but they will be there as goals to work toward in the future. How long it will take to reach these goals, we cannot know until the criteria are established and we have knowledge of air quality in any given area.

When these criteria are established, any State or local area can properly evaluate its total problem. The States are being pushed by the demands for clean air by the public to set their own criteria without adequate information. If through lack of information a State sets its criteria too high or too low, it would be subject to severe criticism.

Information is needed as to the reliability of various types of sampling and monitoring equipment since many new agencies are now or soon will be purchasing this equipment. These instruments are in many cases complex. Comparative information concerning their selectivity and reliability is almost nonexistent. It would be highly desirable for the Public Health Service to establish an air pollution equipment testing program with frequent reports to state and local agencies as to equipment performance. This is very important since these instruments are essential to any air pollution control program and are an integral part in the establishment of ambient air criteria.

Newly developing concepts in the sharing of financial resources, local, State and Federal, need to be explored. How can the States share in the greater financial resources of the Federal Government, at the same time maintaining their independence and their responsibility in air use management? The Declaration of Purpose in the Comprehensive Health Planning and Public Health Service amendments of 1966 (P.L. 89–749) states a principle of Federal-State collaboration which is new in the health field:

"The Congress declares that fulfillment of our national purpose depends on promoting and assuring the highest level of health attainable for every person, in an environment which contributes positively to healthful individual and family living . . . that attainment of this goal depends on an effective partnership, involving close intergovernmental collaboration . . . and that financial assistance must be directed to support the marshaling of all health resources—National, State and local . . ."

The key concepts here and in the Clean Air Act are those of a partnership on a continuing basis and the acknowledged need to use Federal funds to support the State and local health programs.

Turning to the matter of interstate air use management programs, it appears that programs aimed at management of specific interstate air pollution problems are indicated. These programs may well be intended to achieve minimum standards for "interstate air" established by the Federal government on the basis of sound air quality criteria. Some have this option: where effective action to implement Federal standards is not taken, then direct Federal intervention appears justified.

The panel noted some potentially serious impediments existing or developing in the path of the establishment of interstate programs. An attempt has already been made by the States of Illinois and Indiana to enter into an interstate compact under the provisions of the Clean Air Act. For nearly two years the Congress has failed to approve or disapprove this compact. Because such inaction is deleterious to the development of interstate compacts, the panel feels Congressional action should be forthcoming. It is also noted that no Federal interstate action, requested or initiated by the Secretary, is known to be under way in the Illinois-Indiana area.

There are a number of Health, Education, Welfare interstate actions, either already under way or contemplated. The panel hopes that the long-term effect of these actions will be favorable, not only in development of interstate programs but in programs managed by the States themselves.

The panel urges that more intensive efforts be directed toward acquainting legislators at all levels of government with the problems of air use management.

In summary, it appears that there are two pressing and related needs in State and interstate air use management programs: (1) the proper development of new, and the improvement of existing, programs; and (2) the establishment of air quality criteria by the Department of Health, Education, and Welfare, upon which these programs must in part be based.

It was propounded by one of the panelists that the limited capacity of the air to cleanse itself, coupled with the worldwide meteorological patterns, may at some time in the future produce such dangerous conditions as to pose a threat to man's existence on this earth.

In my own opinion, all of these actions are made more difficult and more pressing, and may ultimately be doomed to failure, by the world's burgeoning population. We must come to grips with the question of population management as a key factor in environmental management, and soon.

F

LOCAL AND REGIONAL AIR POLLUTION CONTROL PROGRAMS

ROBERT A. LOW
Member of City Council
New York City

This report is for Panel F which was devoted to local and regional air pollution control programs. The panel met jointly yesterday afternoon with Panel E whose report was devoted to state and interstate air pollution control programs.

Because two participants on our Panel F represented geographical areas in which the air pollution problem is interstate in nature, it was not easy to delineate the subject matter between the two panels. However, we have come up with many of the same conclusions that emerged from Panel E. Perhaps the fact that these conclusions are here repeated will give added emphasis and encourage speedier action in the suggested direction.

What was immediately apparent from the presentations of Panel F participants was that their attitudes toward regional approaches were strongly influenced by their local experiences. The number of recommendations for regional control was equal to the number of participants. For this reason, we have in a number of cases given the specific views of individual panelists.

There was one theme that ran through all the discussions—a dissatisfaction with present efforts for regional control of air pollution.

There was general agreement that the problem had to be attacked in a coordinated program in which local, regional, State, interstate and even Federal and international agencies ultimately would have to cooperate. Professor Neiburger of the University of California at Los Angeles, in his paper to the joint panel, analyzed some of the weather factors in determining the limitations of regional governmental structures which would be capable of dealing with the problem. He indicated that "a control program for a metropolitan area properly should include a region much larger than the metropolis if all the persons who are affected are to be considered." He suggested "a diameter for the control program region three times the largest dimension of the fully developed metropolitan area." But Professor Neiburger emphasized that of more importance than the delineation of an area of optimum size for air pollution control programs was the need for effective cooperation at all levels of government.

Mr. Jean Schueneman of the Public Health Service, gave us a roll call of communities and his summary as to where we stand today at the local level reads:

"Local air pollution control agencies have carried out the majority of the regulatory work in air pollution control in the past and will likely continue to do so in the future. Local program activity has expanded substantially in recent years, especially since Federal grant funds became available in 1965. Additional expansion, to perhaps fourfold current activities, is needed. Particular attention is needed to extend air pollution control activities throughout the areas of major urban centers where the current activities are confined to the central cities. Staffing of local agencies will be a continuing problem until salary schedules can be improved and the pool of trained manpower can be expanded."

In the discussion and from Mr. Schueneman's paper, it became apparent that perhaps 15 to 20 percent of positions in State and local governmental air pollution control agencies are vacant at present. Mr. Schueneman said that in his judgment the problem no longer was the availability of training facilities in universities, but was to get people into the training programs. There was reference to raiding by some control agencies of personnel from other agencies through offers of more attractive salaries.

"There is a need," Mr. Schueneman said, "for greater attention to enunciation of public policy by top community officials and establishment of air quality goals. Air quality measurement and generalized pollutant emission inventories are proceeding fairly well, but air quality measurement should include a wider range of pollutants, and specific detailed information on pollutant sources should be more generally obtained and organized. Information on detrimental effects of pollution is usually less than adequate and in some communities is even less satisfactory. Design and enforcement of emission control programs by local agencies are satisfactory in only a few areas. Many emission regulations are too lenient to ensure adequate air quality, and enforcement efforts are generally far short of needs. Long-range planning, an important program element, is generally neglected and must soon be improved.

"Local air pollution agencies have begun to carry out their responsibilities, but effort put forth thus far constitutes only a beginning. There is still a long way to go."

Mr. Schueneman's paper raised several major questions, one of which was: What is the proper agency to handle air pollution control programs in cities of less than 100,000? It was suggested that, in those cases, local health departments should be responsible for handling programs, but that many of these departments would need to develop methods and contracts that would establish public policy and that they would need to become responsive to the electorate's demand for air pollution control action. In larger areas there was considerable question as to whether air pollution control activities should be incorporated in a city health department or in some other agency, or whether an independent agency should be established.

Mr. Schueneman's overall conclusion was that local and regional programs must be the key and that we need at least four times the present effort to cope with the problem. He said very simply, "it is touch and go whether we get air pollution or whether air pollution will get us."

Mr. H. Clifford Mitchell, Director of the Division of Environmental Health, St. Louis County Health Department, and I both come from areas where the problem is interstate in scope. We presented papers treating the problem as one requiring a regional approach across state boundaries. An amendment to the Clean Air Act seems to be called for, to provide use of the grant-in-aid formula as leverage to obtain regional emission regulations and ambient air standards. This could be done by permitting the withholding of Federal funds to any local control agency that refused to enforce regional regulations and standards. An interstate air pollution control district might be established by action of the New Jersey and New York State Legislatures with power to enforce these regulations and standards, but I advocate that enforcement be left to local political subdivisions, perhaps countywide in scope. Under both the Highway Act and the Mass Transit Act, regional planning is already a condition for the receipt of Federal funds, and a similar approach might speed up a regional attack on air pollution.

In the New York-New Jersey area we now have an abatement proceeding. The Governor of the State of New York, in October 1965, initiated an abatement proceeding against the State of New Jersey. Thereupon the Governor of New Jersey initiated an abatement proceeding against the State of New York. We are going to have a conference in New York on January 2, 1967. I submit that this act should be changed to secure cooperation among the states rather than adversary proceedings.

Mr. Mitchell, who had just completed over three years in a new regional program in the St. Louis, Missouri and East St. Louis, Illinois metropolitan area, listed the following guidelines for the development of a program: (1) get expert help; (2) base the program on a considerable amount of technical information and data; (3) study the findings to develop air quality goals and emission limitations; (4) plan the control approach carefully after selecting air quality goals and emission limitations; and (5) consult with representatives from industry, local government, and State government. Mr. Mitchell's presentation illustrated agency teamwork by the State, Federal and local agencies under which all important community factions were involved in program development and in which maximum cooperation of news media was obtained and utilized. This development in the St. Louis area might well be studied because many of us in other areas are faced with the same type of regional problems.

Mr. Mitchell outlined some specific results. In one area, encompassing a county containing 100 cities, an ordinance incorporating regulations and standards has already been adopted and a program established. In the City of St. Louis a program has been functioning for many years. Legislative bodies in these two jurisdictions are now updating their control ordinances. In the Illinois part of the region the responsibility for air pollution control rests with the State Air Pollution Control Board and it has undertaken to establish State-wide standards and regulations which will be applicable in the East St. Louis, Illinois region. At the same time, the States of Illinois and Missouri are considering an interstate compact that will unify the entire region into one single operating unit.

Mr. C. D. Ward represented Warren M. Dorn, the Chairman of the Los Angeles County Board of Supervisors, and noted with satisfaction the presence in the various panels of numerous elected officials. He felt that this was extremely important because effective control not only required expanded jurisdictional concepts, a responsibility requiring action by legislators, but that legislators must have the knowledge and the insight to provide the legislation which should anticipate technological progress.

Mr. Ward pointed to the fact that in California legislation requiring automobile controls was enacted before industry itself had come up with the answers. He stated that this example illustrated "the concept that air pollution programs must lead, not follow, the development of hardware of control." Indeed, he said, "most of the progress has been met when industry has been faced with a regulation with which it must comply." Mr. Ward, reflecting the views of Los Angeles, advocated the establishment of a separate agency with administrative powers. He emphasized the need for legislation at the local level preventing pollution at the source. It may be of some interest that the legislators on the panel took this view, while the experts generally favored emission limitations, a difference in emphasis. Mr. Dorn advocated the issuance of permits as a condition to the use of equipment that might produce pollution. He pointed out that such legislation is easy to enforce, since the only question is whether the defendant has a valid operating permit.

Mr. Dorn concluded that the tough Los Angeles Air Pollution Control Law not only had not slowed down the economy of the region, but actually had stimulated growth.

Legislation that will curtail pollution at the source appears to be more effective than the setting of emission standards. The New York City Council's new air pollution control law provides for the upgrading of public and private incinerators and heating equipment. Where there are 17,000 private incinerators and tens of thousands of heating units, it literally is impossible to monitor all these sources of pollution. I stated to the group that sulfur dioxide could not be monitored from all these sources. The new law in New York City provides for the gradual reduction of the solid sulfur content of fuels within five years to a level of 1 percent. The door is open, however, and if emission standards can be met by the removal of sulfur dioxide at the stack, the lower sulfur content of fuel would not be required.

Mayor Ralph S. Locher of Cleveland favored the central city taking the initiative in developing regional air pollution control programs. He felt that the States and the Federal Government should continue to take the lead in research through universities. But he emphasized that the local agency, preferably incorporated in an existing city health department, could best provide the foot soldiers in the attack on pollution. He reasoned that the cities had ongoing organizations of professionals, that the bulk of sources of pollution existed within the city limits, and that the cities had planning functions often embodying many factors that related to air pollution, the location of facilities, municipal incinerators, factories, etc. He noted, too, that municipal officials would be particularly sensitive to pressures from citizens' groups urging action in the field.

Mayor Locher advocated Federal and State assistance for communities adjacent to the central city in order to obtain the regional approach to which we all subscribe. He indicated that there should be State criteria and minimum standards for surrounding communities, and went so far as to suggest that communities which did not enforce the State criteria should be fined. Mayor Locher advocated a partnership in which the Federal Government would provide funding, research and leadership: the State Government, funding, legislation and community standards: the central city, funding, technical expertise, and effective enforcement: and the suburban areas, enforcement in concert with the central city under an effective contractual enforcement arrangement with that central city.

Some of the recommendations that came out of the general discussion were:

(1) In view of the numerous experiences in developing regional programs or regional approaches to air pollution control, the Public Health Service should publish a report on these efforts.

(2) In view of the great importance of training new personnel, in both technical and management aspects of air pollution, it would be well to increase technical training and make available management and related training now being given by the U.S. Civil Service Commission, the Public Health Service, and others at a Federal level, to employees of State and local agencies. An innovation was reported as being carried out by Rutgers University, which provides extension service training for air pollution control personnel.

(3) The role of the medical societies in air pollution control should be encouraged. Medical personnel should participate in speakers panels. Medical societies and their personnel should explain and support legislation. Medical societies and personnel should collect information on the effects of air pollutants and help to organize the groups needed for collecting such information.

In summary, three of the panelists advocated establishment of independent agencies to control regional pollution. Both panelists concerned with interstate pollution suggested the creation of some form of interstate compact. As Chairman of the Panel, I advocated an amendment to the Clean Air Act to provide for the withholding of Federal funds from local control agencies which refuse to adhere to regional regulations and standards. Mayor Locher, recognizing the desirability of regional control, believed that the key effort should remain within an ongoing city health department.

The consensus was one of dissatisfaction with present regional approaches and a recognition that we require new political concepts, the cooperation of the political and the engineering communities to come up with answers, and finally that we have action at all levels of Government.

G

ROLE OF FEDERAL GOVERNMENT IN AIR POLLUTION CONTROL

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Pollution Control
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The Federal government has been involved in air pollution control activities since 1955 when the 84th Congress passed "An act to provide research and technical assistance relating to air pollution control." The Clean Air Act of 1963 broadened the role of Federal government in air pollution control as follows:

1. A directive for development of air quality criteria.
2. Authorization for Federal assistance grants.
3. Authority for limited participation in legal regulation of pollution.
4. New authorities relating to the conduct and support of research.

In large measure our panelists talked in terms of the problems and techniques of implementation. Our morning speakers concerned themselves with air quality standards (essentially what we want in the air); emission standards (what enters the air); and abatement (how to keep it out).

The afternoon speakers talked in terms of political realities, what is needed on the part of industry, the public, and government agencies to achieve effective controls.

There was a consensus among the speakers that the Federal government should be responsible for establishment of air quality criteria. As a practical matter, only the Federal government is relatively free from local pressures that have been exerted on local government officials and have served to cripple the setting of effective criteria. There is little doubt that the use of air quality criteria will increase to provide guidelines which should or should not be emitted into the air. Thus far use of these criteria has been meager.

Other factors also must be taken into consideration in setting emission standards. It was observed that the standards adopted in a community must reflect not only the economic and technical feasibility, but also a host of local considerations. It was proposed that the Federal government publish manuals that would present suggested emission standards based on a variety of such local conditions.

During the discussion a proposal was made that consideration be given to authorize the Federal government to establish emission standards applicable to industries of national significance. Enforcement of these standards should be delegated to the States, which in turn would further delegate enforcement to local and regional enforcement agencies. The speakers believed that local control of intrastate problems is sound and feasible, that there is too much variety in local conditions nationwide for there to be an effective centralized control by the Federal government. They foresee, however, that there will be increased Federal abatement activity in areas of direct Federal involvement: for example, federally financed urban renewal, community development, public housing, highway construction, etc. They agreed, on the other hand, that the Federal government has a very definite role to play in abating interstate problems and in the control of motor vehicle emissions, which the Federal government already has under the Clean Air Act.

Aside from this, the panel felt that the Federal role should be limited to a strong partnership with State and local agencies. There is a need for new mechanisms of administration to achieve effective air pollution control on a regional basis and to meet a problem which extends beyond the political boundaries of States, counties, and municipalities. To effectively control air pollution in our large metropolitan areas where the problem presses the hardest, regional or airshed programs are needed. The airshed, similar to the watershed, might encompass all pollution sources in an area.

It was proposed that the Clean Air Act be amended to authorize the Secretary of the Department of Health, Education, and Welfare to establish such airsheds throughout the country, and to work with States and municipalities to establish air pollution control programs in these regions. The control programs would involve participation by the Federal government, as well as by State and local governments. It may be expedient to establish the regions in two phases with interstate regions first and intrastate regions later.

The panel felt that government in general has not met the responsibilities nor the challenge of a rapid-changing environment. A whole new organization is needed, which can adjust itself to new problems in a new way, including such concepts as airshed, watershed, revaluation of land use, density concepts, and planning.

The problem of emission standards for national industries will very likely be the subject of exploration in the next session of Congress. The panel unanimously agreed that action programs should be moving faster. The consensus was that efforts are lagging behind technical capabilities, and that new forms of government be tested to handle these problems.

U.S. DEPT. of HEALTH

H

ECONOMIC AND SOCIAL ASPECTS OF AIR POLLUTION CONTROL

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Regional Planning
Committee, Catholic
University
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Unpolluted air is a natural right of every human being. Unpolluted air is the inherent right of every individual in our society. Denial of this right through progressive negligence imposes personal, societal and economic costs on the American people which are increasingly serious. These costs, in addition to their essential injustice, become more and more intolerable as we reach toward the Great Society. Among such costs are deprivation of the joys of a pleasant environment, a general unease, and specific penalties on the lungs, hearts and property of individuals, as well as more obvious spoilage of materials and disruption of work and play habits.

The panel has been unanimously inspired by the enthusiasm and conviction it has discovered here on the part of active citizens, specialists and officials alike. The panel is convinced that the American people are activated in this critical area, as in so many others, by a new social conscience, and that they now rise to defeat the menace of polluted air. The nation will simply no longer submit to this short-changing of its right to environmental decency. Robert Frost said once that the problem of our time is "how to crowd, but still be kind." We have begun to know that the problem of our time is also how to crowd, but still be clean, and that indeed crowdedness, kindness and cleanness are essentially interrelated in megalopolis.

It was suggested that we have now reached a maturity in our approach to the problem of assuring citizen and business support for effective air pollution management, from which three conclusions emerge: First, grass roots community action to back control programing will move to include not only those diseased personally by air pollution, but also all citizens of our metropolitan areas whose disadvantage, while not so radical, is daily more evident. Second, it will become increasingly clear to industry that cooperation with control programing is good business as well as good citizenship. Third, to assist in this catalysis of new citizen involvement, the middle leadership levels of society are challenged to action. These are universities, churches, labor, business, and farm organizations. Air pollution should stand high on their continuing agenda and should be featured in all their urban affairs conferences. For example, the chairman of the panel stressed that the churches of the nation should become as committed to the fight for the human right of clean air as some of them have been committed to the fight for other civil rights.

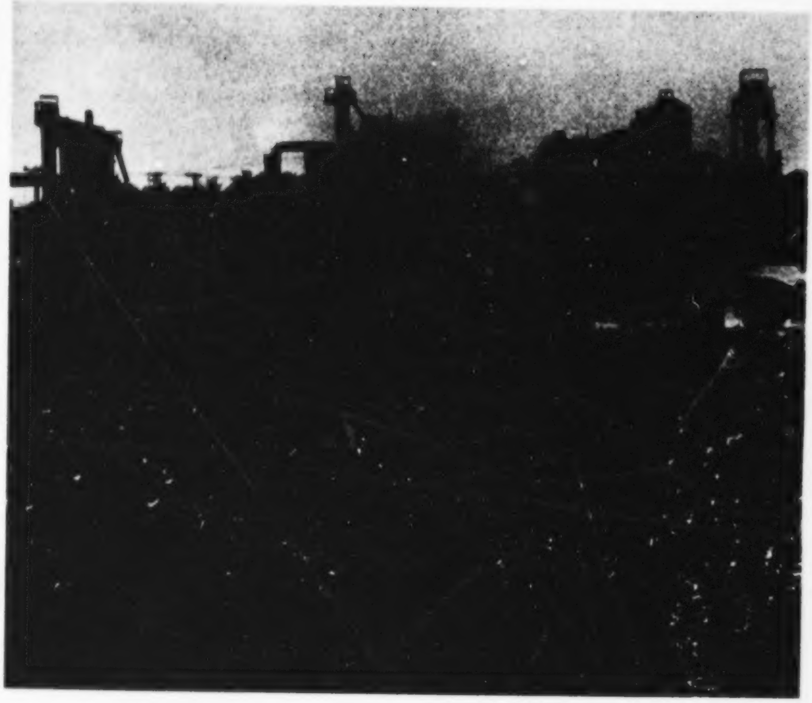
The panel proceeded to identify a number of factors in our national air pollution experience: The first was the degree of sophistication in current air pollution cost estimates. A substantial debate developed at once. It was suggested, on the one hand, that two major uncertainties survive: (a) in the area of quantifying psychic and esthetic damages from air pollution; and (b) in the area of identifying in a mixed cost situation that proportion of damage which can justifiably be attributed to air pollution.

It was suggested, on the other hand, that current costing is at least adequate to establish a giant need. It was contended that to try to add the costs of the effects of air pollution, exactly quantified, to the costs of the control of air pollution is a questionable necessity. All agreed, however, that though more information is required, enough is now known. The "malifits," i.e., the private and common "bads" fairly assigned to air pollution, are sufficiently great to demand a notable expansion of, rather than a timid extrapolation forward from, our present levels of control program activity.

The second factor was planning and zoning as part of air management. The panel concurred that both planning and zoning are important, but cannot be the only tools in the staging and implementation of air control programs. There was agreement that the job of adapting planning techniques and structures and metropolitan political institutions to the findings of the air pollution control scientists will be as complex as technical control studies themselves. A growing concern on the part of the Department of Housing and Urban Development and the City and Regional Planners, generally, to work with and in air management was noted. It was stressed that this concern must apply in both old cities and new towns.

The third factor considered by the panel was the relative utility of regulatory mechanisms. There was sharp disagreement on this subject. It was held, on the one hand, that tax incentives to relieve industrial pollution are "simply payments for the wrong thing." On the other hand, a proposal to substitute "effluent fee schemes" with a limited reliance on other enforcement programs for such incentives was challenged as unnecessary, unworkable and confusing.

The fourth issue was the relationship between air management and other environmental management efforts. A distinction was drawn particularly between control of unclean water and control of unclean air. The airshed is more diffuse and involves many more individual decisions for control than does the watershed. While surely there can and must be interfaces in approaching all aspects of the metropolitan environment, it was suggested that too



much diversity here could limit rather than enhance the attack on the very peculiar menace of dirty skies.

Fifth consideration was the health cost of air pollution. It was stressed that environmental purity is basic to all programs designed to step up the well-being of metropolitan man. Congressman Fogarty emphasized the positive factor in health. He cited the World Health Organization definition: "Health is a state of complete physical, mental and social well-being. Governments have a responsibility for their people which can be fulfilled only by the provision of adequate health and social measures."

The panel concluded that effective air management will impose significant costs in the public and private sectors as well as on the single citizen. These costs, however, will be far less than the geometrically progressing damages which clearly threaten if such management is not undertaken now. Government at all levels must confess and reform its own polluting self before it can justifiably command its constituents to a sense of real responsibility for clean air. Many types of industry require clean air for their own activities; all industries are becoming increasingly sensitive to the fact that an essential corollary to man's right to unpolluted air is that no organization has a vested right to pollute the atmosphere.

Recognizing the survival of critical technical questions, the panel concurred in an urgent appeal to Americans everywhere to insist on their right to effective air pollution control programs. This insistence, the panel warned, must be more than general. It must be more than a one-night noble stand. It must be constantly and continually expressed. It must be applied particularly at the points and at the times of budget preparation, when metropolitan plans and zoning ordinances are proposed, and when enforcement devices are under legislative scrutiny. In older communities, citizens should demand mandatory referral to effective air pollution control authorities prior to any major land use changes. Federal money for urban highways is now contingent on clear evidence of actual metropolitan planning. So too, model cities should be funded only if they have moved comprehensively toward cleansing their metropolitan environment. Or at least, pollution should figure with poverty as a principal target in the first model city grants. In new towns, perfect laboratories exist for experimentation with community development policies as a control tool.

In the long run, here as elsewhere in the democracy, society is only "citizens to the nth power." One or two committed people in each community can activate the forces of demand for clean air. Carlisle said once that "the battle itself is victory." The panel is convinced that enough Americans are aroused in effective anger against air pollution to make control now for clean air an essential ingredient of the Great Society.

QUESTIONS AND COMMENTS

VERNON G. MacKENZIE: We have now reached the open discussion part of our program. Professor Benjamin Linsky, West Virginia University, has requested permission to discuss the differences among industries as to their attitudes and actions and some related comments on the panel reports.

LINSKY: Some of the younger men in the power industry might be surprised to learn, contrary to this morning's reports, that their industry was a late entrant in the use of electrostatic precipitators and tall stacks and fabric filter collectors. They might also be interested in hearing that powerplants are still being designed and built in cramped valley bottoms, without space for future exhaust-gas treatment for sulfur oxides and perhaps oxides of nitrogen. I question whether the reduced national fly ash tonnages that were reported here are of very much help at any given local site, where one plant may have worn out collectors or obsolete plants are still in use because of the unanticipated, unplanned growth in electrical usage in the area.

I would like to comment on the cost of residual fuel desulfurization that was mentioned, and its significance in terms familiar to those who pay the bills and vote on programs, or vote for legislators who vote on programs. It is not generally recognized that the cost of fuel represents only 10 percent of the meter bill in the usual New York City household. With an average meter bill of $16, the fuel might cost about $1.60 for $9.55 per ton delivered coal. An increase of 10 percent would mean an increase of 16 cents a month, 10 cents more than covers good fly ash recovery. An increase of as much as 40 per cent in fuel cost—which might result from the use of fuel processing control methods just now being made available—would be 64 cents a month. In New York City and in some other areas the approved rate structure has a fuel cost elevator clause.

The average household meter bill in one large midwest city is $9.40 a month. The fuel used to generate this electricity costs about 80 cents a month. A 40 per cent addition to this would not bulk large.

In discussion of industry's attitudes and actions on air pollution and its control, the term industry was used as though industry were a monolith. We all know that this is not true, that industry type A is not industry type B or type C. We also know that, within an industry, Company No. 1 is not the same as Company No. 2 and has different attitudes and patterns, without regard to local pressures. We also know that within any single company the different branch plants operate under different rules and different patterns. As people learn that a branch plant elsewhere has been cleaned up and one of the same type in their own town has not been cleaned up, this monolith concept of industry will simply evaporate.

MacKENZIE: There are a number of comments directed at our panel members. The first is from Robert C. Miller, of Cincinnati, Ohio, who suggests that exhaust control capability should be included in the safety requirements being considered by the Department of Commerce.

As a worker on the Federal level, I think a brief reply from me may be helpful. Mr. Miller's comment refers to new legislation which requires certain safety provisions on newly manufactured automobiles. This legislation includes a requirement that the States "set up safety inspection systems" under penalty of losing some of the Federal highway assistance funds. I am assuming that Mr. Miller's comment refers to the desirability of providing for State or local inspection of pollution control systems on automobiles. As a matter of fact, discussions of combining these are currently under way with the Department of Commerce and, to us at the Federal level, it looks as though it would be a reasonable thing to combine the two desirable objects of safe transportation and clean air. I think the comment is a good one.

JOSEPH E. GRAY (*National Crushed Stone Association, Washington, D.C.*): I would agree totally with you. We too have been interested in this development at the Federal level and it is also being practiced in the State of California, where safety inspection does include provision for the checking of the vehicle emission control system. I know that there is considerable effort in other States to include this as part of their inspection program.

W. W. OWEN (*Executive Vice President, City Transit Company, Dayton, Ohio*): I have two questions—What is the height of the highest practical smokestack? How effective is this in relieving surface air pollution as compared with other means of controlling emissions?

WESSENAUER: There are stacks in existence now 800 feet high. TVA has one at its new Bull Run Station. There are stacks being built in Ohio of 825–850 feet. There are new plants in Pennsylvania with stacks of 1,000 feet and possibly even higher. It is recognized, of course, that you can't continue to increase these indefinitely to very great heights, but, considering the velocity of the plume, the effectiveness has been measured on a number of these high stacks and there are a lot of technological data collected on them. These data indicate that there is a substantial reduction in the concentration of SO_2 at ground level through the use of the very high stack.

MacKENZIE: Certainly it is true, and it is recognized technically, that discharging the pollutant emissions at an elevation considerably above ground level will result in a degree of dilution before these contaminants get back to ground level and affect people or produce adverse effects on vegetation or property. Those emissions which are emitted close to the ground do not have as wide a pollution range as those that are discharged higher up.

LOW: I would like to make two points. New York City is essentially downwind and the question that arises in my mind is whether high stacks in Pennsylvania or Ohio, etc., west of us, are going to help us if effluent gases are heading in our direction. The second point is that in New York City the SO_2 levels are highest under the high stacks, despite the disclaimer of the utility which constructs the high stacks. I wonder whether Professor Neiburger has any comment about the emphasis on high stacks.

NEIBURGER: With respect to Councilman Low's comment, there is no question that over flat terrain in ordinary conditions the maximum concentration of pollutants at the ground is greatly decreased by the increase in height of the level of emission.

Also, the concentration at all positions downwind is decreased. The effect farther downwind is much less than the effect close to the stack, so that probably, if you were 50 or 60 miles from New York City, you would get essentially the same concentration of pollutants originating in New York City whether they came from a stack 800 feet high or from ground-level. But closer to the stack the levels would be greatly reduced because of the high stack, and under ordinary circumstances this reduction is enough to prevent deleterious effects.

In the case of the high stacks in a built-up region, where you get a lot of stirring just due to the fact that the winds are blowing across a very rough terrain—buildings, etc.—this effect is much less important because downdrafts occur. Downwash caused even by a single building is adequate to bring the effluents down to the ground rather close to the stack when they are still highly concentrated. So having the emission from a high stack isn't nearly as effective when you have a built-up region as it is when you have a flat terrain with a single stack in it.

Another aspect relates to my most important point. If you have just a single stack 50 miles away from New York City, by the time the effluent reaches New York it has been diluted. Mixed with other air, it becomes very dilute and even has some chance of being altogether removed. On the other hand, if you have 1,000 stacks to the windward of New York City, you're going to have very high concentrations. Of course, many activities, and more types of sources, not just industrial stacks, but also motor vehicle exhausts, domestic heating plants, incinerators, etc., reinforce one another and so you get rather high concentrations even if the stacks are at 1,000-feet elevation.

Next you have to consider the fact that the dilution that I talked about means just spreading out into other air and not complete removal from the air. We had some comment in another plenary session about the fact that air has natural cleansing processes built into it and so usually, by the time the air comes all the way around the earth and reaches the United States again, it's completely clean once more. The pollutants have been removed, we think, almost completely and we can start polluting it all over again.

In the case of carbon dioxide, the evidence is that this cleansing process doesn't take place completely. Even though there are a lot of processes that remove carbon dioxide, in the last half century its average worldwide concentration has increased about 10 percent. We don't know about other pollutants because they weren't measured 50 years ago. But it may be that they also are building up slowly. Unless we know that they are being removed completely, we can expect the gradual build-up that was referred to by Dr. Frechette as possibly leading to an intolerable concentration, a concentration too noxious for the sustenance of human life, not just in metropolitan areas like New York and Los Angeles, but all over the world.

It seems to me that it's important to recognize this development at an early stage. We are presently using a disproportionate fraction of the world's total energy here in the United States—5 percent of the world's population using 35 percent of the energy—but the developing countries are all seeking to raise their standards and they will all be wanting to use enough more energy to enable them to enjoy the high standard or from ground-level. But closer to the stack the levels would be greatly reduced fossil fuel. Unless, on an international basis as well as on national and local and interstate bases, we start developing standards and control programs, we may find that even though we clean up the air here in the United States the activities in other countries will raise the background concentration of pollution on a worldwide basis to an intolerable level. Therefore it seems to me vital that we begin now, through international agencies and by international compacts, to attempt to establish standards of clean air on a worldwide basis.

MacKENZIE: I'm sure Dr. Neiburger is aware, and all of you may also want to know, that there are a number of international organizations that are very much interested in the subject which he has mentioned. These include the World Health Organization, the World Meteorological Organization, and, in Western Europe, the Organization for Economic Cooperation and Development, in which the United States is also participating as a member. There is not only interest in these international agencies, but there have been specific recommendations by the President's Science Advisory Committee that so-called base-level measurements (and this is the worldwide problem) should be given greater emphasis and attention than they have received up to now.

MARK MOONEY, Jr. (*Maryland State Board of Health, Baltimore*): I would like the panel's reaction to the idea of imposing a one-cent-a-gallon Federal tax on gasoline, the proceeds of which would be returned to the States for air pollution control activities or for the *free* installation of control devices on cars.

LOW: It's a novel idea. I hesitate reacting off the top of my head. Maybe Mr. Grant, who has had a little experience with this problem, might have a better answer. I understand that in California the ladies screamed for controls, and then, when the men in the legislature came to imposing these requirements for in-use cars and the figure of $40 to $50 came out, the legislature did not go ahead. The girls wanted the controls, but the fellows didn't have the dough.

GRANT: I don't know whether or not it's appropriate for me to elaborate on a one-cent tax or a tax of any type. It was commented that there were few legislators here and that this reflected a lack of interest on their part. I can assure you that they are very interested in any proposal of a tax of one cent or more on a vehicle and its operation, at least in California, where you have 11½ million vehicles. It would add up to a substantial amount of money. This is a legislative question. Certainly the acquiring of funds to provide emission control systems of any type would be a desirable thing, but whether or not it is practical economically and feasible politically is another matter.

LOW: I might say to the gentleman who proposed this that I certainly will carry this idea back to members of the New York State Legislature, because this offers a possibility for increasing the funds for air pollution control work in the automotive field. I think there is a germ of an idea here and I think it requires discussion at the State level. Mr. MacKenzie has suggested that I am a legislator. The fact is that I'm in a City Council and I can't vote for or against a proposal. But we do have in New York a good number of energetic State legislators and this is certainly something that I will carry back to them from this conference.

PAUL J. KAUFMAN (*State Senator, Charleston, West Virginia*): I have a double question: First, should regulatory agencies be required as a matter of law to include representatives of polluting industries? Second, should specific emission limitations be statutory or be established by regulations?

FRECHETTE: I'd be more interested in including representatives of the lay public than members of specific industries. On the second question, my feeling is that instead of having emission standards established by statute, they should be set by regulations. These obviously will have to be changed from time to time. This is a process of development, of evolution, and the less firm statutes are involved the better.

MacKENZIE: Specifically, how do you define esthetic values? In the absence of accurate definitions how can it be stated what the esthetic effects of pollution are?

HOWES: This question was submitted very early in our panel. I threw it out to the panelists, hoping that some of them might care to talk about it en route to other answers, if not directly. As I recall, there were no takers.

I think we can only expect a somewhat general understanding of esthetics as involving the conveniences, the beauties, the sensitive privileges, the joys, the equity factor in civilization. This is not decor only, not just the frosting on the cake, but perhaps it can be summed up as the beauty, the general ease, the environmental comfort of life, something like that.

No member of the panel rose to define esthetics more particularly. The topic of the panel, however, was social and economic costs. I think we can quite properly accept the idea that beauty, joy and ease or the deprivation of them constitute a cost factor. This is especially true in our current revolution of instant expectations. People in our urban areas simply will no longer put up with a blight of ugliness, odors and smog.

What it finally comes down to is a situation similar to that we encountered in our city planning classrooms. Instead of spending ten lectures trying to discover precisely what a community is, we accept a workable definition and move to remedial action. Here too, rather than allotting an unconscionable amount of time to discussing what esthetics precisely is, we have only to place a sufficiently workable definition of what is generally involved and then conclude that its absence is, however intangible in many instances, a social cost.

JOSEPH J. WEINSTEIN (*Maricopa County Health Department, Phoenix, Arizona*): I want to add a short supplement to Dr. Frechette's remarks on the evaluation of monitoring programs. I think his ideas are extremely wise and would be very valuable to air pollution control agencies, particularly those that are not in position to evaluate themselves. And few are. We had a visit from the Technical Assistance Branch of the National Center for Air Pollution Control. They came in with a viewpoint which was objective and helped us evaluate ourselves. This, I think, is of extreme importance because many agencies which spring up have a tendency to go off tangentially before they know all that they should, or even know the qualities and attributes of the equipment they use.

In connection with the equipment itself, we have some real gripes and, if it were at all possible to establish some sort of clearinghouse of information for the use of new agencies that are about to use substantial sums of money in the purchase of equipment, it would be a great help. We had and have some supposedly sophisticated instrumentation with photocells that are supposed to scan and don't scan, filters that are supposed to filter and don't filter, vapor traps that don't trap vapor.

In one particular instrument, two of our technicians made 25 modifications in the course of one year to make it work. Not only that, but we also sent one of the technicians to a school which was operated by the company which manufactured that particular piece of equipment. At the school a piece of equipment taken off the manufacturing line was in such poor shape that the instructor himself could not put it together to use in the course.

These may be extremes, they may be unusual, but in the course of this meeting I have had an opportunity to compare our experiences with those of some other agencies and I find that ours are by no means unique.

HARVEY LIEBER (*City College, New York City*): You are in favor of control "when possible." Just when is control not possible and how do we determine this?

HUGUET: I think that in our panel discussions of the various industries there were instances in which particulate control in a number of industries was possible and a great deal has been done in these industries. Plans and programs are continuing. It was pointed out that, in some industries as they are now set up for the collection of materials from such things as trash piles, certain types of processes are being replaced by others, and it is extremely difficult, if not economically impossible, to do control work. Improvements in control technology, in the application of devices, and even more importantly in process modifications, are being sought as a means of reducing these.

CLAYTON NYBERG (*Chairman, Board of Commissioners, Portland, Oregon*): Is there any consideration of directing Federal funds to the local and State governments without strings, so that the local administration can meet its responsibility without relying so heavily on the property tax? It seems to me necessary that the Federal Government recognize the nationwide source of its funds (income tax and other resources from the Gross National Product) and convey a portion of these funds back to the local level.

MacKENZIE: If I may say so, this is something that is far broader than the subject of this conference, which relates to air pollution specifically. Any funds devoted to air pollution control are used for that one specific purpose. But the question relates to the far broader question of financing the activities of State and local governments generally.

DOROTHY A. FRASER (*Member, New Jersey Citizens for Clean Air, Allendale, N.J.*): How can county governments fit into the regional and municipal framework?

LOW: The role of the county government in a regional approach? The difficulty I alluded to when I said that enforcement should remain with local government while standards and regulations should be set by a new regional agency was that in the metropolitan New York area, we have some 22 counties and, according to a recent estimate, 1,400 different political subdivisions of one type or another. It seems to me that even in enforcement we want an agency of sufficient scope that we can cut through the hodgepodge of smaller governmental units. At the same time, we don't want to build a mammoth enforcement organization, for such an organization is repugnant to most people in this country.

This is a general statement. To be specific, the City of New York includes five counties. Obviously, enforcement there should not be left to the counties because there is little county government left in New York proper. On the other hand, we have a Board of Supervisors in Nassau County and in Westchester County, and it would seem to me that an entity of that size perhaps would be the type that we should seek in the area of enforcement.

Across the river in New Jersey, there is also a tremendous multiplicity of jurisdictions and we have to cut through them and erect some kind of unified enforcement approach. Of course, the State says it would like to retain this function. Maybe that will be the approach on the New Jersey side, but in general I think enforcement has to be local. People don't like mammoth government. I think enforcement is more effective from smaller units, but we do need the regional approach when it comes to standards and regulations.

COMMENT: Possibly the same thing might be done as in Dade County, Florida. Rather than set absolute standards which all local government in Dade County must accept, minimum standards were set which all the various governments had to observe, though they could set stricter standards of their own if they wanted to. Possibly in this case also the regional unit might set a minimum floor and then let local jurisdictions rise off the floor if they wish, rather than requiring a total compliance in every area with a fixed regulatory pattern.

JOHN G. LOEFFLER (*Mechanical Engineer, Bureau of Prisons, U.S. Department of Justice*): One of the eternal truths of the Bible is this: "By their works ye shall know them." Has our air pollution control program passed this simple test? Secretary Gardner said in his keynote speech: "The truth is that we are actually losing ground in the fight against air pollution. The smog continues to grow more dense even as we talk about it."

During the last few days we have heard about the brave clean world we could expect if we could reduce the emissions per vehicle of sulfur dioxide, carbon monoxide, hydrocarbons, etc. This was qualified by a rather wistful remark: "However, we will have 120 million vehicles in 1980."

People, this prophecy was made as if it were holy writ. I don't buy this prophecy. In point of fact, the number of vehicles is going to be ultimately limited by planning it that way or it will be accomplished by catastrophe. The number of vehicles and the quantity of gasoline burned are rising at an alarming rate, while the quality of the air is deteriorating at a sickening pace. The concentration of emissions in the atmosphere required before an air pollution alert is called is ridiculously high, in terms of human comfort. The poor performance at all levels of government in guaranteeing clean air represents a dereliction of duty. This was concluded in the Panel G summary.

This happened, not through a failure of technology, but through a failure at the political level, as a result of currying favor with voters through building of freeways, failing to enact much higher taxes on automobiles and fuel, and failing to provide adequate public rapid transit.

In July of this year the Senate voted 85 to 0 to authorize $9.5 billion for highways over 2 years. Only $.15 billion was voted to assist cities with mass transit. Then the politicians come to the scientists and engineers and scream for answers to air pollution, or air poisoning. Gentlemen, you have been had.

The Malthusian Law states that the population tends to increase faster than the food supply, resulting in famine. I state that the burning of fossil fuels tends to increase faster than the technological state of the art of controlling the resulting emissions. India and the United States solved their problems with similar logic. India has in the midst of famine some 100 million sacred cows which they refuse to reduce in numbers although they have reduced the rations per cow. We have in the midst of foul air some 100 million vehicles, a number which we refuse to reduce although we try to reduce the emission per vehicle.

The Vice President in his excellent speech stated that experts should be on tap but not on top. I think we're going to have to be concerned with what goes on at the top if clean air is to be had. I propose the following programs:

1. The Congress should impose an air pollution tax, not less than 15 cents per gallon of gasoline, diesel fuel, and aviation fuel. According to statistics by the Bureau of Public Roads, which as been conspicuously absent at this conference, this would raise the overall cost of operating the average vehicle in this country less than 10 percent and would raise it still less in countries of Western Europe. The cost of air pollution must be borne in direct proportion to the amount of pollution. If I drive 35,000 miles per year, I should pay more than the one who drives 5,000, and the money should go to the Treasury, not the highway fund.
2. There should be a massive subsidy of rapid transit systems for our cities.
3. Society must be restructured by means of tax incentives and other means to reduce dependence on the private automobile.

The above program would have the immediate effect of reducing gasoline consumption, by reducing pleasure driving, which has been reported as the number one pastime in America. It would tend to affect millions of individual decisions, reverse the flight to the suburbs, and stop the decay of our big cities. In addition, the ambient air quality must be paramount in establishing criteria, using pre-World War II air quality as a baseline.

Massive talk about reducing emissions is inadequate when the quality of the air is deteriorating. We must stop equating air quality standards with the currently possible instead of the desirable, or else we will be like the doctor who said the operation was a success, but the patient died.

To those vested interests who may oppose this program, I can only say that the battle is joined. Turn off the ignition and stop letting the goats watch the cabbage patch.

THOMAS B. YOST (*Assistant Attorney General, State of West Virginia*): Assuming that no person, in industry or not, has the right to pollute the air, isn't it irrevelant that this conference is concerned with the cost of abating pollution? It must be done. Let the polluter find the cost.

COMMENT: One of the big problems is the question of allocating costs. Is this the elimination of a public "bad" in which the public is so mightily involved that it ought to be paying a portion of the cost to the private polluter, or is it simply something the private polluter himself has to take care of? I think it's a question not only of costs and fees, but also one of determining what device, what techniques, the public can employ rightly and justly to cut back pollution. Then it's a question, since we probably can't eliminate pollution completely, of how far we ought to go and what kind of cost the public will be willing to bear. I shudder to think of what would happen if a councilman in New York City advocated a 15-cent increase per gallon on gas. Certainly in Nassau County he wouldn't get very far. Maybe in the city he might.

I think it's an extremely complex problem. The right of the community to protect itself against common "bads" does exist, but how do you allocate the costs?

STANLEY: May I take the liberty of drawing some analogies to the kinds of problems we face here and the semantic impasses that we're beginning to feel. I think that in many respects we are faced with the same problem that we had when we stopped taking free enterprise literally and established agencies like the Securities and Exchange Commission, the Food and Drug Administration, and the Interstate Commerce Commission. This was a reaction to an abuse inherent in the whole concept of free enterprise.

Unfortunately, we didn't have any models from which to work and we developed a series of laws and regulatory bodies to deal with the problem. Bankers, on the other hand, operated national banks with whole new concepts of banking. A double-entry bookkeeping system that applies to business does not apply to a national bank or an international banking situation. We are again taking our problem with respect to air pollution, which is a byproduct of the affluence we all want more and more of, and trying to fit it into a cost-benefit analysis, which was never designed for this sort of thing. It has nothing to do with the way you derive your cost and evaluate your benefit in the area we are dealing with here.

Secondly, you're trying to fit a problem which is primarily one of social value into an economic framework. I think that what we need is the same kind of thinking that the military has come up with to solve certain problems which were beyond the range of Napoleon and other old-time military leaders. We must set up new forms of government interrelationships without threatening the existing form of government, which was set up for purposes entirely different from the handling of air, water or land pollution problems.

ALEXANDER Z. PETRI (*Councilman, Ecorse, Michigan*): I am very much impressed with the conference we have had, particularly with the theme, "Control Now for Clean Air." This is not the first conference I've attended; I first attended an air pollution control conference about 10 years ago. I don't believe we have made a tremendous amount of progress since then. We're still talking about the same kinds of things.

I think the things that are being talked about are important. We need some Federal standards which would be uniform. The Federal Government and all levels of government should recognize that "pollution is pollution is pollution," and it makes no difference whether this is in the middle of the desert or in the midst of New York City. A certain amount of emission is pollution and it should be regulated and controlled or prohibited, whether it is local, regional, State or interstate.

If we're going to make any real progress, I think that we have to take the tools that are at hand in each area, whether these be ordinances specifically designed for pollution control or nuisance ordinances and that we undertake those enforcement actions that are necessary in any particular situation. Let us act now, and, as our theme says, control now. Let us utilize what is available to each particular unit of government, and, if the next ascending unit of government sees that the lower level of government is not doing its job, let them step in and immediately cite a violator.

It has been my experience over the years that nobody does anything that is going to cost him any money or any inconvenience unless he is prepared to do it. So I say: Take back from this conference all the fine information that we have and let us accelerate and proceed along the lines of developing the ideal organizational patterns and the ideal standards that are being recommended. Let us do something *now* in all of our local areas and keep this dirty stuff from going out into the air.

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December 14, 1966

PLENARY SESSION

Chairman Richard A. Prindle, M.D.
Director, Bureau of Disease
Prevention and
Environmental Control,
U.S. Public Health Service
Washington, D.C.

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". . . for more than ten years has presented to the American people the complex scientific and social issues in air pollution . . . his efforts in information and education developed wide public understanding, and made 'air pollution' a household term . . ."

THE ROLE OF THE CONFERENCE SUMMARIZER

THOMAS F. WILLIAMS
Chief, Office of Legislative and Public Affairs, National Center for Air Pollution Control, Washington, D.C.

At the opening of this conference, Vice President Humphrey described himself as a generalist. The public also, as you know, is a great generalist—sometimes to the chagrin of the many specialists whose contributions are so essential to the control of air pollution. Within a few minutes, the moment of truth for this national conference will begin, for this meeting belongs to the American public who paid for it, called for it, and expects results from it.

The conference summarizer plays the role of the public's most direct and intimate representative here. As he views our accomplishments and our failures of these past three days, so also is the public apt to view them.

For many years, the Public Health Service—and many other agencies—have included people who are skilled in communications to act as conference summarizers. They can, with their insight into communications and the public mind and temper, interpret the voluminous technical and scientific data in a way that will broaden and deepen public understanding.

Our summarizer is, by his own definition, only an "instant expert" in air pollution. He occupies a distinguished position in the field of news and public affairs broadcasting, and his expert judgment—however instant—can hardly be questioned.

It was just six months ago that Daniel Schorr returned to this country from twenty years of reporting international news in Europe and around the world. Mr. Schorr was recalled to the United States by CBS News to begin the examination of all aspects of the developments involved in what has come to be known as the Great Society program. When Richard Sellant, the president of CBS News, announced Mr. Schorr's new assignment, he said: "It is clear that a social revolution is in progress in America, toward which President Johnson has addressed himself in his Great Society program. That revolution requires a great reporter to analyze the progress being made. In Daniel Schorr we have a senior correspondent who has witnessed Europe's renewal in the postwar period, and will bring his experience to bear on America's brand of renewal."

Interviews with Khruschev, Adenauer, Nehru and Castro give him more than enough background for consideration of the domestic problems still before us.

After two previous tours of duty in Washington, Mr. Schorr has come back for a third term. His first television documentary since his return was "The Poisoned Air," in which he examined with insight and skill the air pollution problem countrywide.

As the representative of the public to this conference, Mr. Schorr is admirably qualified to weigh and interpret the papers that have been given, and the conclusions that result from them. His "View from the Outside" is a picture taken with the eye of the camera and the mind of a trenchant observer.

A VIEW FROM THE OUTSIDE

I speak today not as a dispassionate correspondent, but as an American; what I say will be editorial, perhaps critical. Perhaps I can say that if anything qualifies me to speak to you today it is that no one who works in television is entirely a stranger to air pollution.

After these three days, you have undoubtedly had your fill of little jokes about air pollution, about smoke-filled rooms, etc. My talk may represent some change of pace, from an inside view of the subject to an outside view of the subject, outside in the sense that I am a layman, and as a layman have trouble distinguishing a crankcase emission from a smokestack plume, and even in defining the difference between effluence and affluence—and I'm not alone in that confusion. I am outside also in the sense that I've only recently returned from many years abroad as a foreign correspondent. Because I have not yet been fully re-naturalized, I tend still to take a rather long view of this country and to make comparisons with Europe.

Over there they have long since learned some of the lessons that we are only starting to learn. Closely-packed communities, centuries old, have learned that their resources—their forests, their land, their water, and their air—are not limitless, and that society must husband what it has. It strikes me that our country is fast approaching the same kind of situation, but, because of a certain lag in realizing this, we have not yet grasped its full implications. We still have a mental image left from our frontier days, when forests could be stripped and buffalo could be slaughtered because there were always more beyond the western horizon. The frontier is gone, and we are starting to learn that we have to make do with what we have. I think we have learned it on land; I think we have started learning it on water; but there is still a certain tendency to extend our "limitless frontier" psychology into the sky. The idea of the atmosphere as a relatively closed envelope of life-giving gases is penetrating only rather slowly.

Our free enterprise system today has a frontier; it is bounded by public need. It can operate freely, up to the point where that free operation starts to do harm to the public. I don't think anyone today would call this idea socialism. The principle is implicit in everything we do from factory safety regulations to city zoning ordinances. It is a principle that we are only starting to apply to the management of the air.

I do not want to suggest that old Europe has solved its air pollution problems—far from it. I came here with the smog of the Ruhr Valley still in my nostrils. I have seen air pollution in Russia, too. But, in communist Russia today, a factory cannot be established in a large urban area without advance clearance that includes approval from air pollution authorities. And, in Russia today, lead is banned from gasoline in cars operating in large cities. And, in Germany, a highly advanced waste-disposal

DANIEL SCHORR
CBS News Correspondent
Washington, D.C.

system near Munich fully consumes what is fed into it and adds no pollution into the air.

I have spoken of a difference in psychology between old Europe and newer America. I must also mention that Europe has a tradition of more centralized government; it has less of a problem of conflicting jurisdictions than we have. I would certainly not say that the Soviet system is the answer to this; in a very, very deep sense, I would rather breathe the air that we have than the air of the Soviet Union. But unless the voluntary partnership, so much talked about during this conference, can be shown to work, air pollution will create a new pressure against our decentralized Federal system. As an outsider, I must note that Illinois, for example, complains of lack of action on an interstate compact with Indiana. I have recently been in St. Louis, which is the victim of considerable air pollution from Illinois just across the Mississippi. And action appears slow on an interstate compact between Illinois and Missouri which would help St. Louis.

One more word about Europe. Earlier this year I was in Amsterdam to cover the wedding of Crown Princess Beatrix. That wedding was disturbed by demonstrations by some young beatnik types who call themselves "Provos," an abbreviation of "Provocateurs." The Provos are a movement, protesting against the status quo and society in general. They're against royalty, and they're against Viet Nam, and they are against air pollution, all things they feel are being inflicted upon them against their will. Little Holland is the first country where I have seen air pollution as part of an ideology, almost a mystique. We have not yet come this far here, but I can tell if you don't already know, that the problem of breathing has become a leading topic of conversation in most of our large cities. With it goes an underlying feeling of hostility directed against "them." People don't say what they mean by "them," but they seem to apply this name vaguely to all constituted authority, and especially to all industry.

In a sense, then, any delay in dealing with the problem of air pollution fosters distrust of our system. In a very real sense, air pollution is a political subversive agent.

I know that progress has been made since the First National Conference on Air Pollution eight years ago. The argument then about whether air pollution was a major health problem appears now to be settled. There is also no longer any serious debate about whether something has to be done about air pollution—only debate about how much, and who should do it, and how much it will cost.

I should like here, as a layman almost as scared of the computer as I am of air pollution, to warn about the overuse of the cost-benefit ratio. Of course, money should not be spent unless benefits are derived. But still, let's not fall into the trap of counting only those benefits that can easily be priced out. The trouble with pollution is that the easiest factors to fit into a cost-benefit ratio—corrosion, soiling, and so on—are the least of our worries. What price do you assign to reducing a man's life by one or two or five years, even if you don't know for sure how many years? What's the market value of the stench that assails a million nostrils? And how do you count the loss to a public utility when its name becomes a dirty word in a big city?

The computer is a great tool; it is encouraging that computers are being applied to the problem of air pollution. With the computer have come a group of high-powered experts—the systems analysts. Yet we cannot wait for the total solution to come from the computer. We can't wait for this final printout. While the computers are whirring, we'll have to go right ahead attacking pollution, source by source.

The panel reports of the eight discussion groups I shall try to synthesize, not claiming to do justice to the carefully balanced language but looking at the results of the panel thinking.

Motor Vehicles. The motor vehicle of the future, says Panel A, must cease to be a factor in adverse air quality. How that will happen the report does not make entirely clear. Secretary Gardner has seen the future in a switch to gas turbine or electric cars. The panel says ". . . No, we'll have to work on improving the existing gasoline and diesel engine." Urban mass transport may help. I see nothing in the report of the suggestion that automobiles may have to, some day, be banned from urban centers.

Heat and Power Generation. Secretary of the Interior Udall did not see any reduction in the percentage of use of coal and oil in the total of our fuels, even by 1980. The panel report speaks of the difficulty of getting enough low sulfur fuel where it is needed. High smokestacks will reduce ground-level pollution, but, I take it, will not reduce total pollution. "There can be no need for complacency," says that report, "but neither is there need for panic." And I shall try to avoid panic.

Industrial Operations. Technology exists for trapping particles, very little technology yet for trapping gases. There is great emphasis in this report on the high cost of controls. Small industries may need government assistance. And time is needed, as "an inevitable ingredient of any sound plan."

Solid Wastes. The panel agreed: Let's ban open burning—enforce realistic incinerator regulations—and continue research and development.

State and Interstate Programs. The Federal Government must be given authority to set air quality and emission standards. The states had better get moving on their programs "lest they lose the initiative irrevocably."

Local or Regional Programs. So far they seem totally inadequate. Mr. Jean Schueneman said we need at least four times the present effort to cope with the problem. Councilman Robert A. Low of New York suggested withholding Federal funds from control agencies that do not meet regional standards.

The Role of the Federal Government. Again, need was stressed for air quality criteria. "Only the Federal Government is relatively free from the local pressures that have been exerted on local government officials." The panel feels that is something to think about. The panel also emphasized the point that "the Federal role should be limited to strong partnership with State and local agencies . . . the panel unanimously agreed that things should be moving faster. The consensus was that the efforts are lagging behind technical capability. . . ."

Amen!

These are briefly, perhaps even a little bit unfairly, my impressions of the reports of the panels after their all-day discussion yesterday. I do not find in these panel reports any great reason for exhilaration. I find no reason to believe that air pollution will not increase in coming years, perhaps even faster than anything that is being done to control it.

Vice President Humphrey said on the opening day of this meeting that this nation can do whatever it wills to do. And he told us that if we can orbit a laboratory and colonize the moon, we can certainly figure out what to do with the fumes that come out of a bus. But on the moon there is no conflict of Federal, state and local jurisdictions; there is no cost-benefit ratio; there is no factor of competitive price to worry about. And perhaps if this country and this world were virgin territory like the moon, we could start all over and do it right. But we will have to take our country as it is today. In some ways it is harder to manage this problem than to manage getting to the moon. The space program does not seriously change anybody's way of doing business—except perhaps to add to the business of some. In air pollution control, on the other hand, we're asking for some very basic industrial and personal changes. They range all the way from changing how the homeowner gets rid of his leaves to how we manufacture steel, how we make electrical power, how we make cars, when and where those cars are allowed to go.

I have heard two concepts spoken of here: I have heard talk of "abatement" and I have heard talk of "control." It seems to me that abatement starts with the pollution we have, and consists of trying to reduce it with the means at hand. Control, on the other hand, starts with a premise that there has to be a standard of how clean the air should be for our health, and that this standard must be maintained regardless of what it may cost. It seems to me that the underlying thought in this conference is still abatement and not control but I think the American public wants control.

We (and when I say "we," it's not a journalistic editorial "we," but I am presuming to speak for the public) we are asking for some very hard and some very expensive decisions. Yes, we are asking even for sacrifices, not in the name of charity, but because the consequences of not making those sacrifices may ultimately cost more. I don't think Secretary Gardner exaggerated when he suggested that after some Black Tuesday or some Black Friday an enraged public may force measures much tougher than anything that is now being contemplated.

I have heard from industry that there is a competitive factor—one manufacturer does not want to be forced to raise his price if his competitor in another state is not held to the same standards. And that's a good point! In that case, the standards will have to be uniform. If that means Federal intervention, so be it! The other day I was in St. Louis working on an air pollution story, and I talked to a representative of industry who spoke with a considerable amount of antipathy about what he called the "feds." When he first spoke of the "feds," I thought he was talking about G-men. I then realized that he meant the Public Health Service and the whole Federal Government. I think it would be a sad and grim day when industry comes to regard the Public Health Service and the whole Federal Government as its enemy.

I find it interesting, also, that the industries that resent Federal control do not seem to resent Federal financial aid in the form of tax incentives and investment credits. I won't quibble: if air pollution control needs Federal subsidy, then let's have Federal subsidy. I suppose, things being what they are, that an industry that decides to serve the public interest should get all possible encouragement from public sources.

If we have to talk about money (that unpleasant word) well then, let's talk about money. How much money is needed to get the job done? Where are the specific plans? How many millions? How will they be spent?

I think all of us are agreed that we should not treat the fight for air pollution as though it were an "adversary proceeding." We should all be on the same side. And yet, I sense that there is a tone of the "adversary" beginning to creep in. I have sensed in the speeches that there are clear differences in viewpoint. I have heard some daring thoughts that have come from Federal officials—thoughts about the gasoline-powered automobile that may have to be banned some day, thoughts about factories that may have to be relocated, a vision of a quite different America. I have not heard such daring thoughts from those whose problems are production, dividends, and engineering problems.

I wonder if we fully realize that the air pollution problem involves a wider problem. In a way our whole system is on trial. We have heard much talk in recent years of the withering of municipal government or the atrophy of State government. Every great problem that cannot be dealt with adequately by existing institutions increases the pressure for new ones, or the shifting of power to some other ones. And if it turns out that factories and cities and States, acting alone or acting in concert, cannot manage their air, then the heat will be on for some system that can. The problem is too big and too pervasive to be left unsolved. We have seen a growing intervention of the National Government in our lives. And, I must say from what I have heard here, that unless something happens more radical than seems to be projected, to deal with the problem of air pollution, there is bound to be further intervention, not because the Federal Government like some ogre, is trying to creep in, but because an aroused public will simply demand it.

Some new combination of authority is needed. Either local autonomies will be merged, or there will be unification in a common purpose, or there will be another kind of authority to fill the vacuum.

The motto of this conference is "Control Now!" And in my arrogated role of speaking for the public, I must ask: "Will the air be less polluted next year than this year? If not, when will the problem be manageable?"

I am informed that since 10 o'clock on Monday morning, when this conference met, some 850 thousand tons of pollution were poured into the air of this country. I don't know how may tons were removed in that time, but it doesn't sound like "Control Now.'

If this sounds like impatience, perhaps even audacity, that's what it is.

CONCLUDING ADDRESS

WILLIAM H. STEWART, M.D.
Surgeon General,
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Washington, D.C.

I can summarize this Third National Conference on Air Pollution in a single word. The word is "Go."

Your three full days of talking and listening have added up to a single clear call for action now to control air pollution. The Vice President sounded it in his brilliant opening remarks, when he said, "I'm a short run man myself. Let's get with it." Since then many strong voices have amplified and elaborated on that theme, but no one has changed it or said it better.

In the high excitement of this conference it is easy to forget that not long ago the call for "action now" came from a few voices crying in the wilderness. It is interesting to look back at the First National Conference on Air Pollution held eight years ago in this same hotel. Many of the same people were here. Many of the same groups were represented, and some of the same things were said.

But there are overriding differences that signal remarkable progress in eight short years. Many of 1958's controversial items are today's launching platform of agreement. In 1958, there was some doubt as to whether air pollution was really a health problem, barring such extreme conditions as those which produced Donora. There was some debate as to whether air pollution was really a national problem at all—and not just a local phenomenon peculiar to Los Angeles, better material for television jokes than for national control programs.

Echoes of these doubts could still be heard at the 1962 Conference. They are not detectable today.

A second striking difference between the 1958 climate and today's is momentum. There were strong and persuasive exhortations to clean up the air then, but the public as a whole was not quite ready to listen and take them seriously. The tide of public acceptance was not yet running.

Today that tide is running very strongly indeed. It has become, in fact, a tide of public indignation. People are angry about the condition of the air they are breathing. They are shouting it loud and clear and their numbers are growing.

Now it is up to us. Up to now, we have been serving as very effective cheerleaders. Now we have got to play the game, and win it.

By "we" I mean all of us. I mean government officials at every level, facing the fact that air pollution control is desirable, achievable, and demanded by the people to whom they are responsible. I mean industrial leaders, facing the fact that nobody accepts the Neanderthal notion of choice between progress and pollution control. And I mean leaders of public opinion, facing the fact that general public indignation now needs to be directed towards specific accomplishment.

In short, we need to channel the rising tide. We need to harness it so that it generates useful power.

And this leads me into the third contrast between our position today and that of 1958. This is probably the most important difference of all. Then we had little more to work with than good intentions. Today we have at our disposal not only the mandate to carry out those intentions, but also a number of practical tools and mechanisms for doing the job.

Some of these tools have been forged through the hard process of acquiring knowledge through our monitoring network. We know far more about what pollutants are in the air, where and when, and in what concentrations. Through research we have further strengthened the powerful indictment against air pollution as a killer and crippler. Through research and development we have found better, more efficient ways of checking many pollutants at their source.

Other tools have been forged through legislative and administrative decisions. The Clean Air Act of 1963 followed close on the heels of the Second National Conference in 1962—a relationship that is not coincidental. This legislation, with its subsequent amendments, has helped greatly in putting knowledge to work.

It has authorized the Federal Government to establish national standards for the control of emissions from gasoline-powered vehicles. And this we have done. It has given us the authority to take action in cases of interstate pollution. And this we are doing. It has enabled us to give effective support to the control efforts of our partner agencies in the cities and states. This has already resulted in substantial strengthening of these programs.

Yet, with all this progress, we have so very far to go. With all this agreement and support, with all these new tools, the darkening air mocks us. Still unresolved are questions of how to deal with air masses which refuse to honor the lines between our jurisdictions—city and suburb, city and city, state and state. Still unresolved are questions of uniform air quality and emission standards—standards that would be helpful to the producer of pollution and the control agency alike. These and many more problems are still waiting for us to match our words with achievement.

This Conference has documented the many damages we do to ourselves by polluting the air. These range across the whole spectrum of human activity—crops that do not ripen, trees that do not bear fruit, planes that cannot land. They add up to billions of dollars of the gross national product converted to gross national waste.

These are reasons enough to throw our full resources into the battle against pollution. But for me there is still a better reason, a higher purpose that is inseparable from our national purpose. We must stop air pollution because it impedes the fulfillment of each individual human being.

A man living in a polluted environment is not a healthy man. This is true whether or not he is suffering from one of the specific ills that are specifically traceable to specific pollutants. We in the health business are deeply concerned with stopping the diseases that pollution promotes. But we are also concerned with sanity as well as sanitation, and we need to think about air pollution as it affects body and mind.

Secretary Gardner made this point strongly in his keynote address: "The purpose of all our efforts is to enhance the quality of life for the people today and for generations to come. We want a humane environment—a benevolent environment in which the individual human being can live fully, in good health, free of the constraints that limit his potential."

There are, therefore, two health targets for our efforts in air pollution control above and beyond the practical considerations of economics. They concern human life and the quality of living.

The first target is safety. To achieve it we must remove from the environment those components which cause or contribute to disease and disability, or at the very least reduce these components to a level which is safe under the worst foreseeable conditions.

The second target is dignity. To advance the human condition we must create an atmosphere—literally as well as figuratively—which contributes to the individual's well-being, his potential for fulfillment.

The first of these targets should represent the very minimum of acceptable achievement. The second should represent a constant aspiration. We are very far from striking either one today. It is high time we hit the first and started working on the the second.

All systems are "Go" for air pollution control.

The nation looks to you in this room to produce the "clear day when you can see forever." Let's not make them wait forever for that clear day.

APPENDIX

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